RESEARCH REPORT 67-1

PREASSEMBLED STAIR CONSTRUCTION

RUDARD A. JONES, AIA
WILLIAM H. KAPPLE, AIA

SMALL HOMES COUNCIL–
BUILDING RESEARCH COUNCIL
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS 61801

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RUDARD A. JONES, A.I.A.
Research Professor of Architecture
and Director, SHC-BRC

WILLIAM H. KAPPLE, A.I.A.
Research Associate Professor of Architecture, SHC-BRC

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I. CONVENTIONAL STAIR CONSTRUCTION

OBJECTIVE OF INVESTIGATION

The objective of the project was 1) to study details of residential stair construction, and 2) develop and systematize methods of stair assembly and prefabrication suitable for utilization in the operation of the retail lumber dealer.

INTRODUCTION

The development and adoption of a standard preassembled stair has lagged behind similar developments of the house, such as windows and doors. For over 40 years, windows and doors have been shop fabricated in predetermined stock sizes, and have been commonly used in construction of houses in this country. Stairs, on the other hand, have been made to fit the dimensions of the house after the house has been framed in. Firms who specialize in shop-built stair assemblies generally fabricate these assemblies only after determining total rise and run, and the width of the stairs. Many other residential stairs have been, and still are, cut to fit the individual condition and are assembled at the building site.

Precut and preassembled stairs can be produced economically only if a limited number of stock sizes will fit a substantial portion of the houses built. To date, the adoption of stock sizes for stairs has been considered impractical due to the variation of floor-to-floor height in normal construction. Even houses with uniform ceiling heights may have different floor-to-floor heights due to the different depths of joists and different thickness of finish flooring materials.

GLOSSARY OF TERMS

The nomenclature describing stair design and construction is used rather loosely in many instances, with the result that confusion is created as to the part of the stair intended. The terms listed below are defined in accordance with their use in this report.

Stair: A series of steps, or flights of steps connected by landings, for passing from one level to another.

Stair case: Stair; also sometimes used to designate the entire assemblage including railings, balusters, etc.

Stairway: Not used in this report. Often used as synonymous to stairwell and/or stair.

Stairwell: The space in the building occupied by the stair.

Flight: A series of steps without an intervening platform.

Step: A single unit of level change in a stair consisting of one rise and one run.

Landing: The floor at the top of a stair, or a platform between flights of a stair.

Starting Step: The bottom step of a stair.

Rise: The vertical distance from the top of one tread to the top of the next tread.

Run: The net horizontal dimension from riser to riser, of an individual step; tread less the nosing or overhang. See also Total Run.

Total Run: The horizontal distance covered by a flight of steps including intermediate platforms.

Tread: The horizontal top surface of a step (upon which the foot is placed), or the member forming the surface.

Nosing: The projection of the tread beyond the face of the riser.

Overhang: The projection of the tread be-

yond the back edge of the tread below.

Winder: A step whose tread is narrower at one end than the other.

Riser: The vertical face of a step, or the member forming this surface.

Open Riser: Step without a riser member.

Floor-to-Floor Height: The total distance from finish floor to finish floor.

Headroom: The vertical distance from the underside of a flight or ceiling above a stair to an inclined line that is tangent to the nosings of the steps of the stair.

Slope: The inclined plane of the stairs established by the relationship of the rise to run of the steps of the stair.

Hypotenuse: The length of the slope of a single step; the third side of the triangle formed by the rise and run of a step.

Carriage: Rough timbers cut to fit below and support the treads and risers of wood stairs. (Carriages are sometimes referred to as rough stringers or horses)

Net Effective Depth: The net uncut cross-section of the carriage.

Kick Plate: Anchorage member fastened to floor under lower tread, to resist the horizontal thrust of the structural stringer.

String (or stringer or string board): An inclined member placed parallel to the slope of the stair to which the ends of the treads and risers are joined. Strings may be structural supporting members or finish trim pieces only.

Open String: A string with the top edge notched to follow the rise and tread. The visible portion of the string is below the profile of the treads and risers of the steps in the stair.

Closed String: A string with parallel edges, a portion of which extends above the ends of the steps of the stairs and is visible as a continuous line conforming to the slope of the stairs.

Housed String: A string which has been routed to receive the ends of the risers and the treads.

Routed String: Same as a housed string.

Wall String: A string located against a wall.

Substringer: A subassembly of a 2 x 4 and a 1 x 6 that is fastened to the wall studs on an incline to serve as a support for the stair string of preassembled stairs.

Soffit: The finished under side of the stair.

Railing: A barrier at one or both sides of the stair constructed so as to prevent individuals from falling off the side of the stair.

Closed Railing: A railing which is formed by a short wall extending above the stair.

Handrail: An inclined piece paralleling the slope of the stair intended for grasping by the hand during ascent and descent of the stair.

Baluster: A small spindle which, in series, supports a handrail. Balusters are fastened a) between the handrail and the treads, or b) between the handrail and a bottom rail.

Baluster Railing: A railing which is formed by a handrail supported by balusters.

Balustrade: An assembly of balusters with attached handrail and supporting rail, if any.

Newel or Newel Post: A main post supporting the handrail of a stair at the top, bottom, or on a landing.

Plinth Block: A wood block used as a trim piece at the top or bottom of the stair to form the transition between the string and the baseboard.

CATEGORIES OF STAIRS

For the purposes of this study, stairs have been categorized as follows:

Primary Stairs

A primary stair is a stair that serves the living areas of the house. Appearance is an important factor in the design and construction of any primary stair.

Service Stairs

A service stair is a stair that serves non-habitable areas of houses such as a basement or attic. Usually less consideration is given to the appearance of a service stair, and the slope of the stair is often steeper.

STAIR PLAN ARRANGEMENTS

Straight Stairs

The most simple type of stair is a single-flight, straight-run stair reaching from floor-to-floor, as shown in Figure 1. In order to make the stair easier to use, and to improve the safety characteristics of the stair, the stair may be built in two flights with a landing introduced at some point between the two floor levels served.

"L" Stairs

In houses which cannot accommodate the total run of a straight stair, turns may be introduced in the stair, as shown in Figure 2.

An "L" stair has two flights placed at right angles so as to permit a 90^{o} turn at the landing which connects the two flights.

A "double L" stair has three flights: a beginning flight, a center flight, and a final flight. Each successive flight is placed at right angles with the previous flight permitting a 90^{o} turn at the two landings which connect the flights.

"U" Stairs

"U" stairs have two flights placed parallel to one another so as to permit a 180^{o} turn at the double landing between the flights.

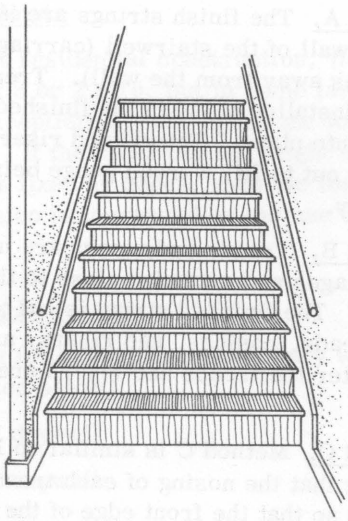

Figure 1

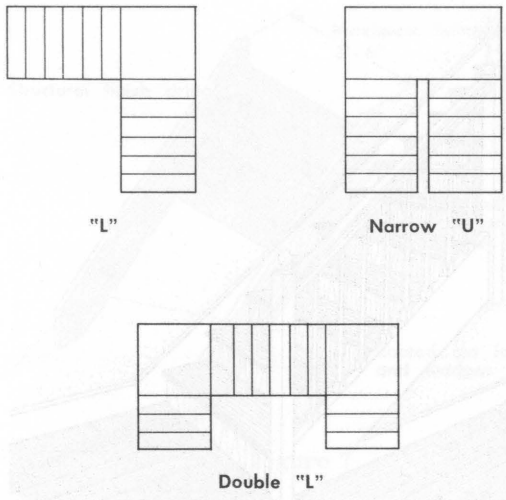

Figure 2

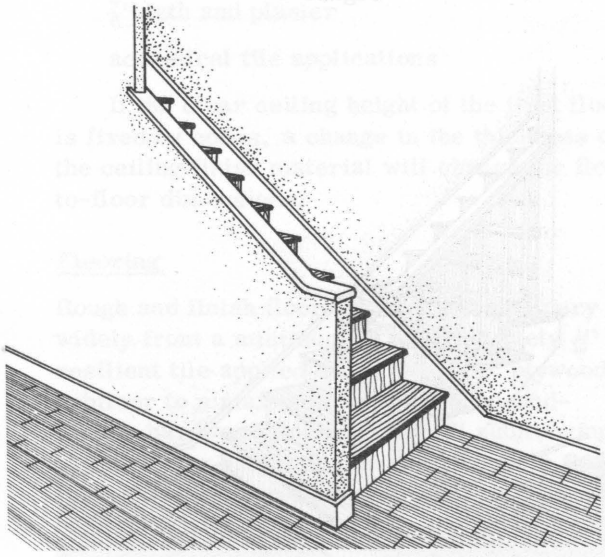

Figure 3

ARCHITECTURAL TYPES

Stairs may be classified in several ways as to their form.

Wall enclosed stairs are completely enclosed by walls. They are necessarily closed string stairs.

Closed railing stairs have a short wall which forms the railing, as in Figure 3. They are necessarily closed string stairs.

Baluster railing stairs have a balustrade-type railing. They may be either closed string stairs (balusters are set upon a rail resting

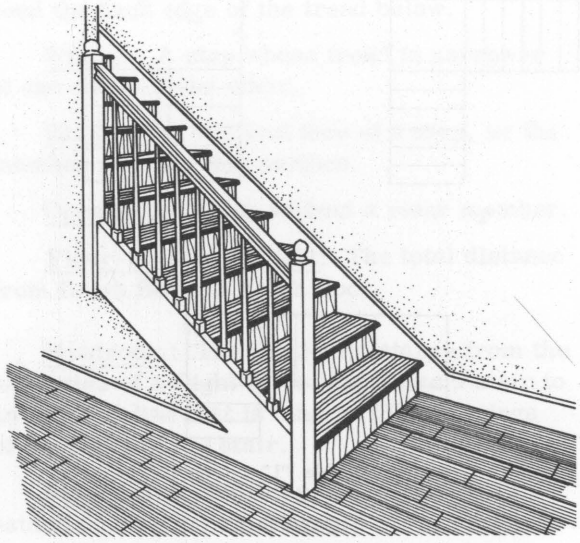

Figure 4

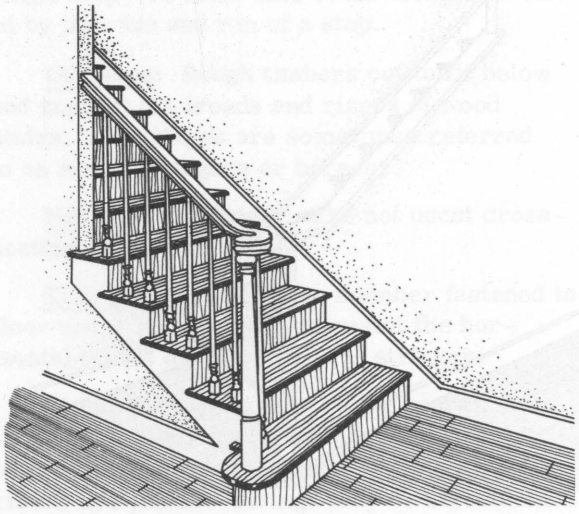

Figure 5

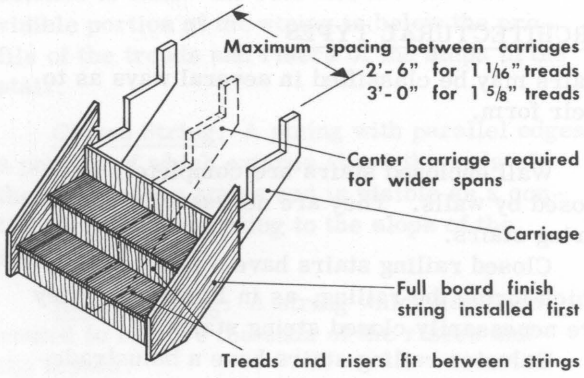

Figure 6

upon the closed string) as in Figure 4, or open string (balusters are set upon the treads), as in Figure 5.

STRUCTURAL TYPES

Type I - Stairs Supported on Carriages.

The most common type of stair construction today in residential work is job-built with the treads and risers supported on rough horses or carriages, as shown in Figure 6. One edge of these sloped structural members is cut in a saw-tooth pattern which matches the rise and run dimensions of the stair. The carriages are installed at the rough framing stage, and temporary treads are generally installed in order that the stair may be used during the construction stage.

For normal stair widths, under usual code regulations, two carriages are required when $1\frac{5}{8}$" treads are used, and three carriages are necessary with $1\frac{1}{16}$" treads (see FHA Minimum Property Standards).

The lower edge of the carriages may also form the support for whatever finish material may be applied to the soffit of the stair.

The finish strings, treads, and risers are installed: 1) after the stairwell wall finishes are applied, and 2) after finish wood flooring is applied on the first floor.

The finish wood floor on the upper level may be applied before or after the stair is installed.

Installation of the finish items may proceed in the three ways described below:

Method A. The finish strings are installed against the wall of the stairwell (carriages are held 2 inches away from the wall). Treads and risers are installed between the finished strings and nailed into place. Treads and risers are individually cut to fit, a tread gauge being used for accuracy.

Method B. Treads and risers are nailed to the carriages and extended close to the side-wall finish. The finished string is cut to fit over the treads, nosings, and risers, and is installed after the treads and risers are in place.

Method C. Method C is similar to Method B excepting that the nosing of each tread is notched out so that the front edge of the tread fits between the strings, while the strings fit against the riser and the run of the tread.

Type II - Stair Supported on Routed Finish Strings (Housed Stair)

An entirely different stair construction system has also been used for generations and is normally used today by firms that specialize in stair construction. This type of stair is supported on finished strings and no carriages are required, as shown in Figure 7. The strings are routed to receive the ends of the treads, risers, and the wedges which are used to hold the treads and risers in place. Wedges, set in glue, are driven below each tread and behind each riser to hold them firmly in place. This type of stair may be used with $1\frac{1}{16}$" treads for widths up to 3'-6" without requiring added support.

Since no carriages are required, some other means is needed to support the stair soffit finish material.

Also, some form of temporary stair is required during the construction period.

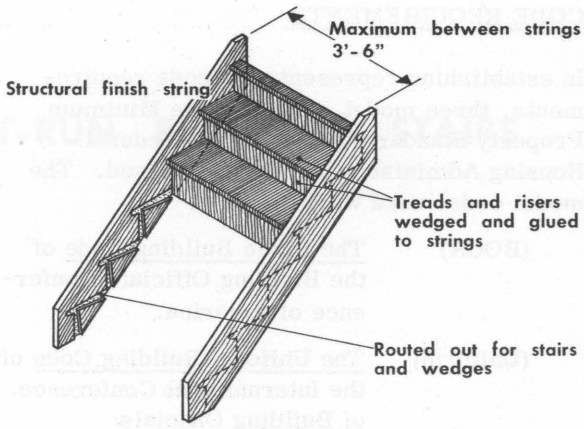

Figure 7

FLOOR-TO-FLOOR HEIGHT

A major factor influencing the design and construction of a standardized stair is the floor-to-floor height.

Ceiling Heights

Clear ceiling heights may be specified in codes. Generally speaking, the minimum clear ceiling height is in the neighborhood of 7'-6", while 8'-0" is the most common.

Floor Joists

In most residential construction, floor joists are 2 x 8 or 2 x 10, but in some large houses with exceptionally long spans the joists may be 2 x 12. If the clear ceiling height of the first floor is fixed by codes, then the floor-to-floor dimension is increased by the use of deeper joists.

Ceiling Finishes

Ceiling finish thickness may vary widely as indicated below.

$\frac{3}{8}$" drywall

$\frac{1}{2}$" drywall

$\frac{5}{8}$" drywall

$\frac{3}{4}$" double drywall

$\frac{7}{8}$" lath and plaster

acoustical tile applications

If the clear ceiling height of the first floor is fixed by codes, a change in the thickness of the ceiling finish material will change the floor-to-floor dimensions.

Flooring

Rough and finish floor thicknesses may vary widely from a minimum of approximately $\frac{1}{16}$" resilient tile applied directly to a $\frac{3}{4}$" plywood subfloor to a maximum of $\frac{25}{32}$" tongue-and-groove hardwood flooring over $\frac{3}{4}$" subflooring. If the ceiling height is fixed, a change in floor thickness will cause an adjustment in the floor-to-floor height.

Wall Studs

Many houses are now framed with standard precut 7'-$8\frac{5}{8}$" studs. In this instance, the variations of the floor-to-floor height will depend upon the depth of the floor joists, the finish floor, and the rough and finish flooring on the second floor.

Range of Floor-to-Floor Heights

If it is assumed that ceiling heights (finish floor to finish ceiling) may vary between 7'-6" and 8'-0", and that other factors may vary as indicated above, the range of floor-to-floor heights is from 8'-$2\frac{11}{16}$" to 8'-$11\frac{15}{16}$". Of these, the most common heights range between 8'-$9\frac{5}{16}$" and 8'-$11\frac{15}{16}$".

CODE REQUIREMENTS

In establishing representative code requirements, three model codes and the Minimum Property Standards (MPS) of the Federal Housing Administration were examined. The model codes used were:

(BOCA) The Basic Building Code of the Building Officials Conference of America.

(Uniform) The Uniform Building Code of the International Conference of Building Officials

(Nat'l) The National Building Code of the American Insurance Association (formerly the National Board of Fire Underwriters)

Pertinent requirements are shown in Footnote 1.

STAIR PROPORTIONING

The relationship of rise to run of a stair must be selected properly to afford the maximum degree of comfort and safety. A number of rules have been established for proportioning stairs. Three of the common rules used are:

2 rise + run = 24 - 25

rise + run = 17 - 18

rise x run = 70 - 75

Footnote 1 - Dimensional Requirements for Primary Interior Residential Stairs

	MPS	BOCA	NAT'L	UNIFORM
Rise, minimum	$8\frac{1}{4}$"	$8\frac{1}{4}$"	$7\frac{3}{4}$"	8"
Permissible Variation in riser height (rise)	0"	----	0"	$\frac{3}{16}$"
Nosing, minimum	$1\frac{1}{8}$"	$1\frac{1}{4}$"	----	----
Width, minimum				
Between walls*	----	3'-0"	3'-0"	2'-6"
Between handrails	2'-8"	----	----	----
Landing, minimum	2'-6" **			
Minimum headroom, primary stair	6'-8"			6'-6"

* Each handrail may project up to $3\frac{1}{2}$" into this space.

** The landing shall not be less than the width of the stairway in which it occurs.

Each stair must have railings at any open portions.

Each stair must have at least one continuous handrail from floor-to-floor. The handrail should be set 2'-8" above the tread at the riser line.

II. PREASSEMBLED STRAIGHT-RUN PRINCIPAL STAIRS

DESIGN OBJECTIVES

To make the stair system suitable for the largest number of two-story houses, it was developed to meet the following objectives:

1. Compliance in so far as possible with maximum number of building codes including the Uniform Building Code, National Building Code and the BOCA Building Code.
2. Installation of the unit after finishes are applied on the walls and soffit of the stair without damage to the finishes.
3. Stair elements small enough to be moved into place after the walls have been erected and finished. (In many houses it will be necessary to move the stair assembly on end through a door opening, in order to install it in the proper position.)
4. Stair elements of light weight that can be easily installed by two men.
5. Minimum number of parts.

SELECTED STANDARDS

To meet the requirements stated above, the following premises were established during the study:

Architectural Form

The preassembled stair is a closed-string, closed-riser type.

Structural Type

A housed-string structural type is used.

Dimensional Standards

Width:

For one handrail

Rough framing opening: 3'-2"

Out-to-out of strings: 2'-11 5/8"

For two handrails:

Rough framing opening: 3'-6"

Out-to-out of strings: 3'-3 5/8"

The above dimensions allow a minimum clearance between wall finish and string on each side of 3/16".

Headroom: Minimum headroom 6'-8"

Run: Standard riser 9 1/2"

Nosing: Standard nosing 1 1/4"

Standard Tread: 10 3/4"

Rise: Standard riser pattern A 7 1/8"

pattern B 7 3/8"

pattern C 7 5/8"

pattern D 7 7/8"

EXPLANATION OF SELECTED STANDARDS

Standard Width of Opening

The recommended standard rough framing widths from stud face to stud face are 3'-2" and 3'-6". The larger width can accomodate a stair with handrails on both sides, as shown in

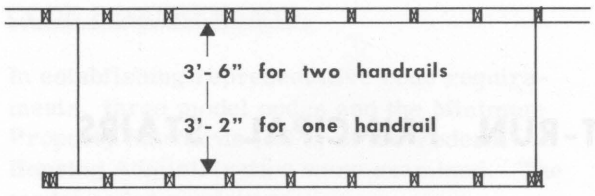

Figure 8

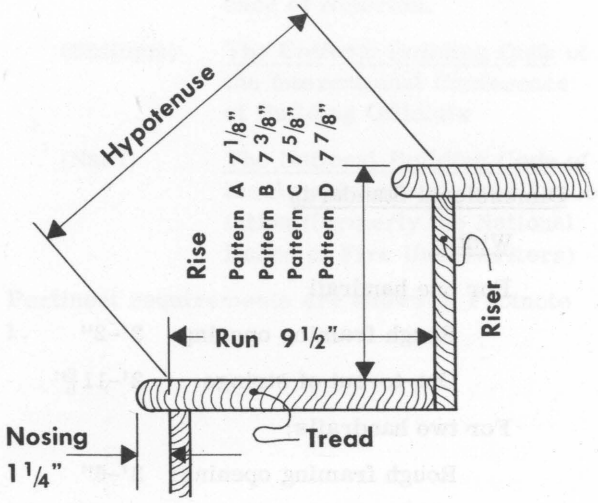

Figure 9

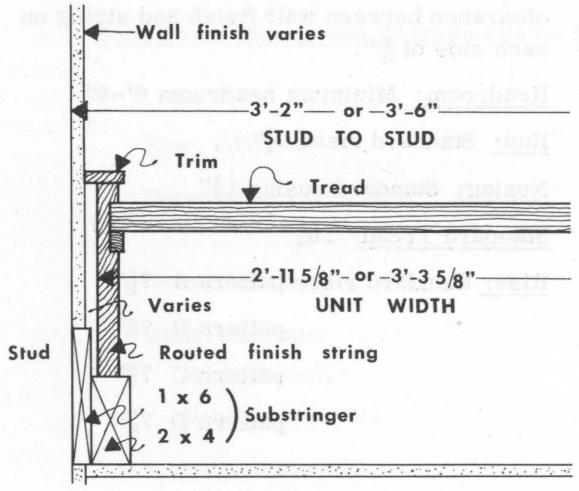

Figure 10

Figure 8. The finish width varies with the thickness of the wall material. The treads fit into routed strings which are spaced to allow $\frac{3}{16}$" clearance on both sides of the stair between the finish string and a wall finish up to 1" thick, as in Figure 9. This clearance is the minimum necessary to set the assembled stair between walls.

Standard Nosing and Run of Step

The standard length of nosing projecting in front of the riser was established as $1\frac{1}{4}$", and the standard run for a step as $9\frac{1}{2}$", as in Figure 10. The standard tread size used is $10\frac{3}{4}$" deep by $1\frac{1}{16}$" thick.

Standard Rise of Step

The selected standard rise heights are; $7\frac{1}{8}$" which is designated as pattern A, $7\frac{3}{8}$" which is designated as pattern B, $7\frac{5}{8}$" which is designated as pattern C, and $7\frac{7}{8}$" which is designated as pattern D. Stairs made from one of these patterns may be installed to fit all floor-to-floor heights above 4'-1", and many heights below that level.

Stairs of any pattern are made to fit floor-to-floor heights that are not a precise multiple of the standard riser height by adjusting the slope of the stair, as illustrated in Figure 11. The adjustment does not exceed $\frac{1}{8}$" per tread. This limit matches the minimum slope required for outside stairs in some building codes. The ranges of floor heights for different riser counts in each stair pattern are shown in Table I - Dimension F and in Table III. For the average conditions, with 8'-0" ceiling heights, 2 x 8 or 2 x 10 joists, and flooring materials of $\frac{3}{8}$" or more, including underlayment, steps of pattern C are sufficient.

Patterns B, C, and D meet the requirements of at least one of the rules quoted in a previous section of this report for stair proportioning. Pattern A falls outside the rules; however, since a riser height of $7\frac{1}{8}$" was needed to expand the range of coverage of the standardized stair, and since it was con-

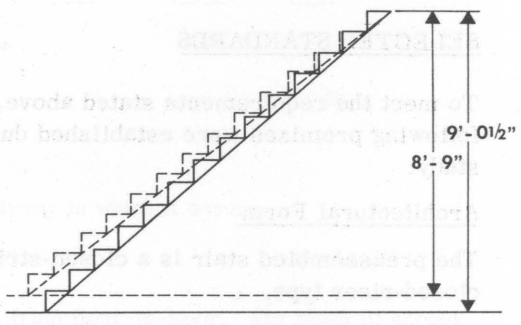

Figure 11

sidered desirable to establish only a single standard run dimension, pattern A was included in the selected dimensions.

DEVELOPED SYSTEM

Stair Sections

In accordance with the objectives previously stated, the system was developed to permit the installation of the stair after the finish wall materials have been applied.

Three-section stair. In the most severe case, the length of a stair section would be limited by the dimensions of the opening for a typical door (for example, a 2'-6" x 6'-8" door). The sections must be short enough to pass through a standard door opening while standing on end, as in Figure 16, before being lowered into the stair well.

A six-step stair section (maximum standard length = 6'-5¾") is the longest section which will meet this criterion. Under these circumstances, a single-flight stair with a floor-to-floor height greater than 8'-0" must be constructed in three sections.

Two-section stair. A stair may be installed in two sections with floor-to-floor heights in excess of 8'-0" provided the clear opening in one sidewall at the foot of the stair is at least 9'-0" wide, as shown in Figure 17. In this case a 9-step section may be installed. The estimated weight of a 9-step stair is 165 lbs. Two men should be able to handle this weight, but a third man should be available at the top of the stair to aid in positioning.

DERIVED DIMENSIONS

Considering the selected standards and the varying floor-to-floor heights, the following details and dimensions were derived:

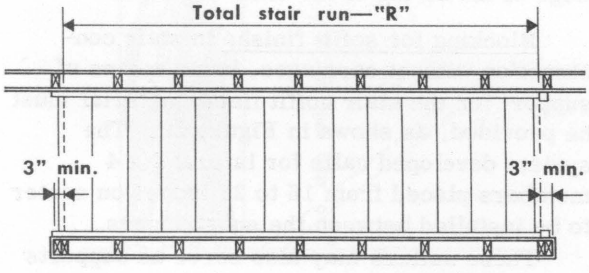

Figure 12

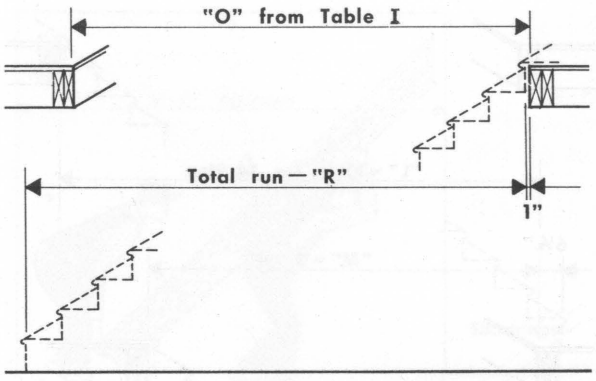

Figure 13

Total Run of Stair "R", (finish to finish) for Layout

The finish stair total run should be planned for a total run slightly more than 9½" per tread, as in Figure 12. This extra space will be needed if the selected pattern must be tilted slightly to fit the floor-to-floor height. With 14 risers, the stair should be planned for 13 treads or a total finish run of 10'-5½'. For other sizes see Table I - Dimension R.

Face of Bottom Riser to Plumb Line from Framing at Top of Stair

The standard position for the framing at the top of the stair is 1" behind the riser. Therefore, the planning dimension from the bottom finish riser to the framing at the top of the stair is Dimension R plus 1", as indicated in Figure 13.

Between Framing on the Second Floor "O"

The framing on the second floor should be spaced to allow adequate head room over the main stair. This clearance varies with the floor-to-floor height, the stair pattern, and the number of risers. (With a 9'-0" floor-to-floor height, pattern C, and 14 risers, the standard minimum distance between framing on the second floor is 9'-9". See Table I - Column O for the minimum clearance for other stair counts and floor-to-floor heights.)

Framing Below Stairs to Plumb Line from Framing at Top of Stairs "L"

In houses with basement stairs, the standard length of the stair well from the framing on the first floor, below the first step, to a plumb line dropped from the framing on the second floor,

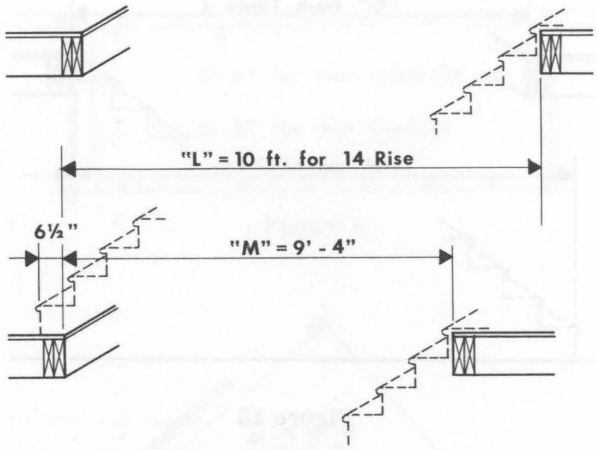

Figure 14

behind the top riser, will depend on the number of risers. (With 14 risers, the standard length will be 10'-0", as shown in Figure 14.) The length for different numbers of risers is given in Table I - Column L. These clearances allow the proper space for the stairs to overlap the floor construction at the bottom and to fit in front of the framing at the top.

Between Framing on the First Floor "M"

The standard length of the stair well below the stairs should be 9'-4" from the framing below the first step to the framing at the top of the basement stairs. This is uniform for all straight-run stairs located over a basement stair and allows adequate head room between the basement stair and the framing below the first step of the main stair.

Wall Framing of Corner at Foot of Stair

In order that the string will not extend beyond the wall at the base of this stair, the wall framing must extend at least 3" from the lower rise line. See Figure 12. Hence the wall framing must extend at least $9\frac{1}{2}$" from the floor framing below the stair.

Wall Framing at Head of Stair

To provide the proper space at the head of the stair to accomodate base trim the same 3" minimum dimmensional standard has been established from the face of the riser to the corner wall framing, or 2" beyond face of framing of the stair opening.

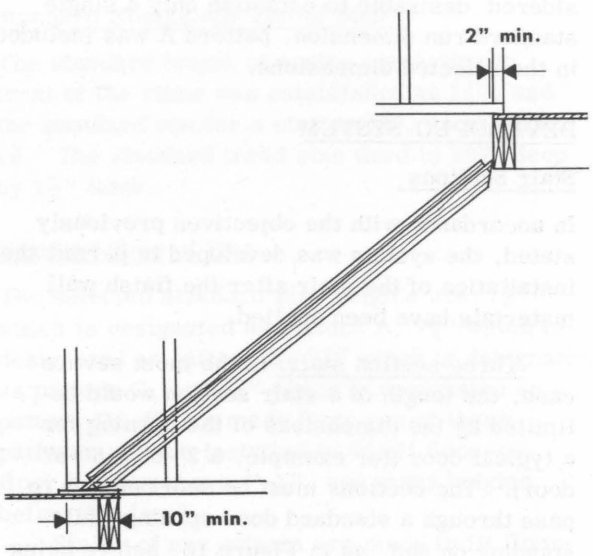

Figure 15

Structural Support

When housed-string type of construction is used for the building of an enclosed stair, carriages are not required. However, since the stair is to be installed in sections, some means of alignment and support are required prior to the completion of the installation. This problem was solved with the introduction of a substringer.

Substringer. The substringer assembly, shown in Figure 15, is made of a 2 x 4 nailed to a 1 x 6. The substringer is nailed to the adjacent wall studs during the framing operation prior to the application of the wall finish. The top edge surface of the 2 x 4 member of the substringer provides a support for the lower edge of the string of the stair sections.

Blocking for soffit finish. In stair construction without carriages, some means of support for the stair soffit finish material must be provided, as shown in Figure 22. The system developed calls for lateral 2 x 4 members placed from 16 to 24 inches on center to be installed between the substringers.

These nailers may also serve as supports for temporary stairs used during the construction operation.

PLANNING STAGE

The following is a description of the planning procedure for a straight stair run over a basement stair.

Select Stair Width

The width must be planned for one of the two standard dimensions, for which the rough framing widths are 3'-2" (one handrail) or 3'-6" (two handrails). In the case of a stair located on an outside wall where a basement stair is to be located below, the extra thickness of the basement wall may make it mandatory to use the 3'-6" rough framing width in order to have a basement stair of adequate width.

Determine Finish-Floor-to-Finish-Floor Height

The number of risers and the stair pattern to be used is determined from the finish floor-to-floor height. This must be checked during the planning stage to allow proper space for the stairs.

Selection of Stair Pattern and Riser Count

After the floor-to-floor height is established, the riser count and stair pattern can be selected from Table III. (For instance, if the floor-to-floor height is 8'-11½", the stair can be made with 14 risers of pattern C, or with 15 risers of pattern A.)

Determination of Stair Run Length "R"

Since the floor-to-floor height for a stair assembly may vary, the total run may also vary. Determine the total run dimensions from Table

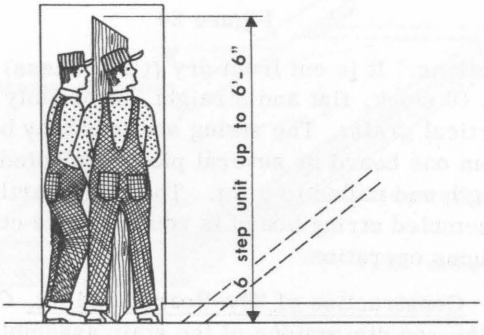

Figure 16

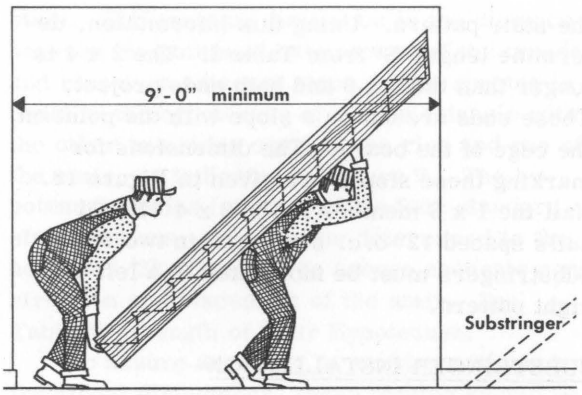

Figure 17

I on the basis of the stair pattern and riser count determined above.

Landing Space - Top & Bottom of Stair

The minimum landing space at the top and bottom of the stair is equal to the rough framing width of the stair plus 3".

FRAMING STAGE-OPENINGS

Once the basic stair design has been selected and its position in the house established, the framing openings and dimensions may be determined.

First Floor Opening (Required only for basement stair)

Width. Previously selected.

Framing under bottom step. Locate this framing 6½" behind the face of the riser of the bottom step as located in the planning stage.

Opening length "M". This length is 9'-4". See Figure 14.

Second Floor Opening

Framing under top stairs. Locate framing by using dimension "L".

Length of Opening at Top of Stairs. Locate framing by using dimension "L".

SUBSTRINGER FABRICATION

Substringers are to be installed as part of the framing operation but should be prefabricated in the shop. The substringer length is established by a) the number of risers, and b)

the stair pattern. Using this information, determine length "S" from Table I. The 2 x 4 is longer than the 1 x 6 and both ends project. These ends are cut on a slope with the point on the edge of the board. The dimensions for marking these slopes are given in Figure 18. Nail the 1 x 6 member to the 2 x 4 with 6d nails spaced 12" o.c. staggered in two rows. Substringers must be fabricated in a left and right pattern.

SUBSTRINGER INSTALLATION

Before placing the substringer, a mark is made on the framing at the top of the stairs, which is labeled "key point" on Figure 19. (It is $8\frac{1}{2}$" below the finish floor level for pattern C. See Table I - Dimension A for other stair patterns.)

The substringer is placed with the 1 x 6 against the studs and the projecting edge of the 1 x 6 upward. This projection will guide the stair assemblies into place, and protect the wall finish from damage. The 2 x 4 projects inside of the 1 x 6, forming a sloping ledge to support the strings.

The substringer is placed at the proper slope by setting one pointed end on the mark on the upper framing, and the other pointed end on a block of finish flooring laid over the first-floor subfloor, as shown in Figure 20. The substringer is nailed into each stud and the upstairs framing on both walls.

Blocking

Solid blocking of 2 x 8 material is installed 8" above the finish floor at the lower step, as in Figure 21. This blocking should be located in relation to the points at the lower end of the substringers. It should extend 2" in front and 6" behind that point. It may be omitted if a stud is located within this space.

If the soffit of the stair is to be finished, 2 x 4's should be toenailed 16" or 24" on center between the 2 x 4 member of the substringers, as indicated in Figure 22.

STAIR FABRICATION

The Finish String

General. The finish string is routed to hold the treads, risers, and their wedging. Like the stair assembly, the string is made in

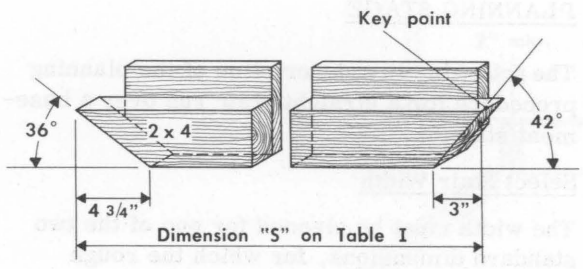

Figure 18

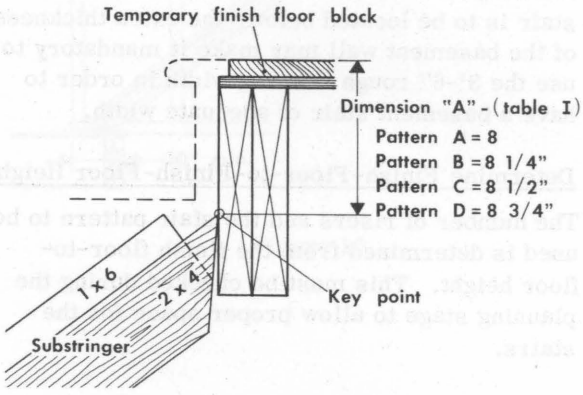

Figure 19

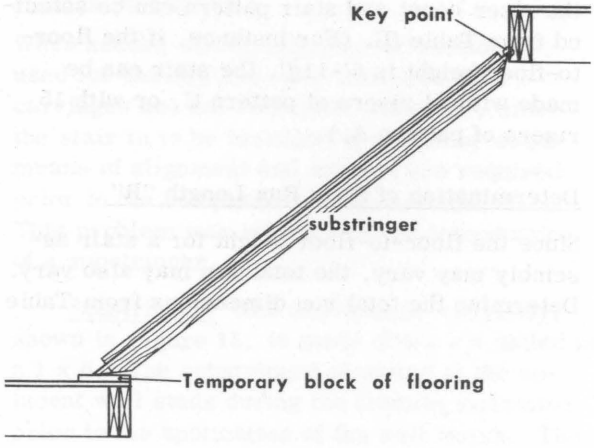

Figure 20

sections. It is cut from dry (12% or less) 1 x 10 stock, flat and straight, preferably with vertical grain. The string sections may be cut from one board or several pieces selected for length and nailed to a jig. The temporarily assembled string board is routed in one continuous operation.

Construction of "Hy-Board" and jig. One of the key dimensions of the stair assembly is the spacing of the steps along ths slope of the

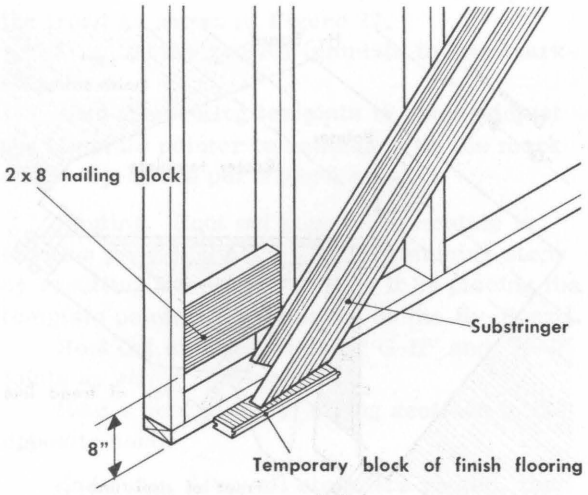

Figure 21

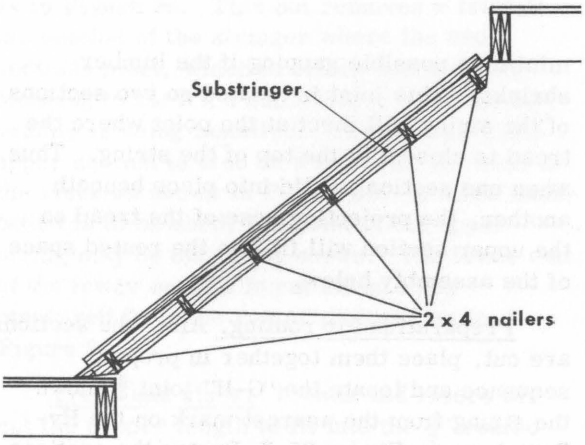

Figure 22

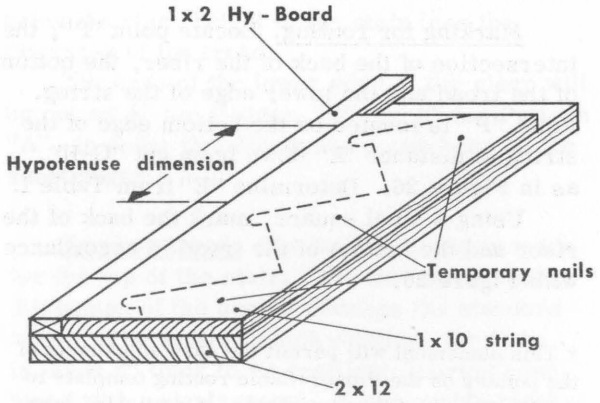

Figure 23

stair. This spacing dimension is the distance between the points of intersection of the treads and risers on adjacent steps. This spacing is equal to the hypotenuse of a right triangle with the other two sides equal to the rise and run of the stair, as indicated in Figure 9. The hypotenuse varies for each of the four standard stair patterns, and must be determined to the nearest 1/32 of an inch to assure accurate construction and placement of the stair. See Table II - Length of Stair Hypotenuse.

To assure accuracy in working with such fractional dimensions, these lengths should be recorded by lines on a measuring board. A 1 x 2 board 16 feet long marked with lines spaced to match the hypotenuse dimension is called a Hypotenuse-Board, or "Hy-Board". These lines may be recorded on different boards for each stair pattern. If all four patterns are recorded on one Hy-Board, the separate patterns should be identified by different colors. This board will simplify the determination of measurements on the finished stringer and its supporting member.

To construct the jig for routing finish strings, the Hy-Board is nailed to a straight flat 2 x 12 member 16 feet long as illustrated in Figure 23.

Length of lower section of string. The length of board for this section varies with the number of steps and stair pattern. Determine this length from Table I - Dimension G. Only the upper end of this piece needs to be precision cut at this time. The relationship of these strings is shown in Figure 24.

Length of middle section of string. The length of the middle section is a multiple of the hypotenuse dimension. Determine the length from Table I - Dimension H. (For four steps of pattern C, it is 4'-0 23/32".) This section must be cut to the precise length.

Length of upper section of string. Determine length of upper section from Table I - Dimension J. The upper end need not be trimmed at this time.

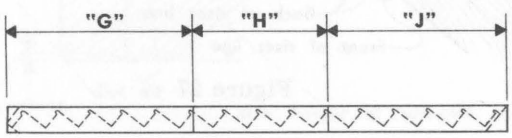

Figure 24

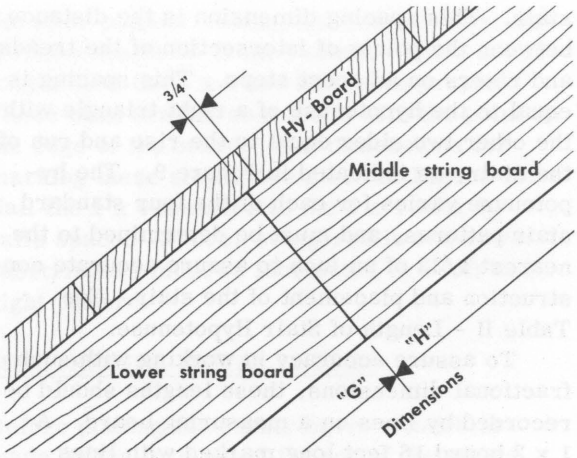

Figure 25

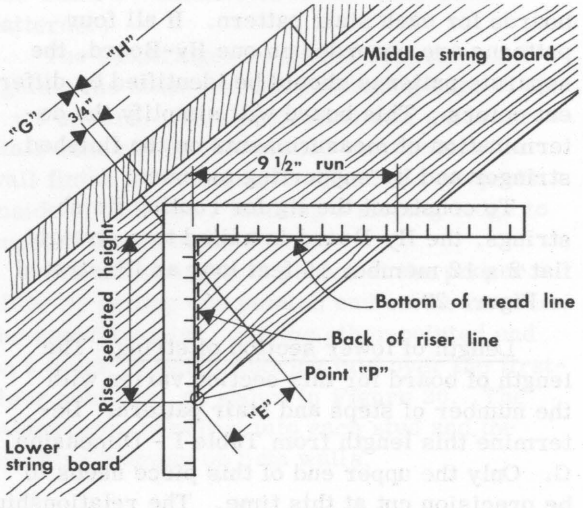

Figure 26

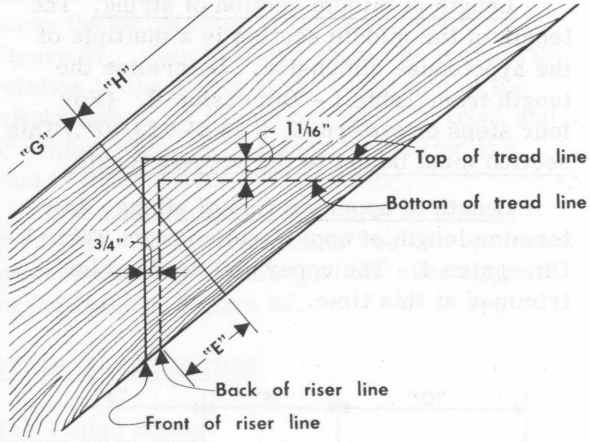

Figure 27

Joints. The joints between sections are cut perpendicular to the grain of the lumber to minimize possible gapping if the lumber shrinks. This joint is located so two sections of the string will meet at the point where the tread is closest to the top of the string. Thus, when one section is slid into place beneath another, the projecting nose of the tread on the upper section will fit into the routed space of the assembly below.

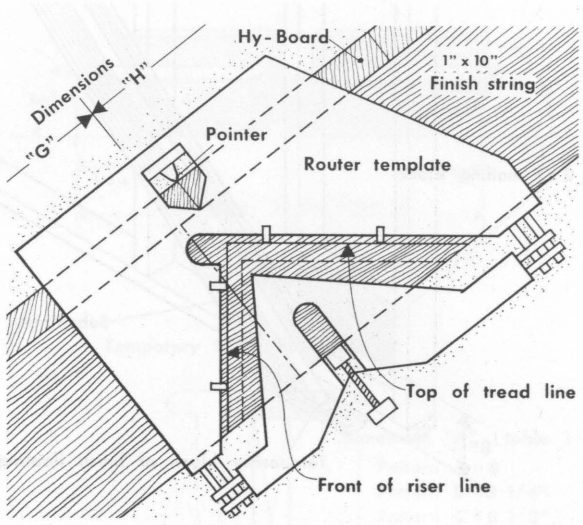

Figure 28

Preparation for routing. After the sections are cut, place them together in proper sequence and locate the "G-H" joint $\frac{3}{4}$" down the string from the nearest mark on the Hy-Board, as in Figure 25.* Fasten the sections to the jig with temporary nailing. These nails may be located in line with the marks on the Hy-Board, 3 inches from the bottom of the string.

Marking for routing. Locate point "P", the intersection of the back of the riser, the bottom of the tread and the lower edge of the string. Point "P" is located on the bottom edge of the string at distance "E" down from cut "G-H", as in Figure 26. Determine "E" from Table I.

Using a steel square, mark the back of the riser and the bottom of the tread in accordance with Figure 26.

* This placement will permit the easy adjustment of the pointer on the Porter-Cable routing template to the Hy-Board. Other templates, if available, may require a different placement which can only be determined by experiment.

Mark the front of the riser and the top of the tread as shown in Figure 27.

Position the routing template to this marked pattern.

With the routing template in place, adjust the template pointer to coincide with the mark on the Hy-Board per Figure 28.

Routing. Rout out step with template in position previously set. Rout remaining steps by resetting template, locating it by placing the template pointer at the marks on the Hy-Board.

Rout out extra portion at "G-H" and "H-J" joints as shown in Figure 29.

Rout a second set of string sections to the opposite hand.

End cuts. After all steps are routed, the sections are separated and the ends are cut. The top cut of the lower and middle string sections is on a line with the back of the riser, as in Figure 29. This cut removes a triangular section of the stringer where the two sections meet, which provides space to nail blocking to the 2 x 4 substringer when the assembly is being installed. The top cut of the upper section is also on a line with the back of the riser as shown in Figure 30. If a low baseboard is to be used, the point of the upper string may be cut off as shown. The lower end of the lower section is cut off on lines measured from the routed pattern, as in Figure 31.

Tread and riser. Treads and risers are cut the proper length to fit into the $\frac{3}{8}$" routed space on the stringer. This length is 3'-$2\frac{7}{8}$" for stairs planned for two rails, and 4" less for the one-rail width. All risers are $7\frac{1}{2}$" wide, except the first one, which is cut to fit over the floor, the width of the finish board being the riser height of the stair less the thickness of the tread.

The ends of the lower edge of the riser will be cut off $\frac{1}{8}$" for Pattern "B" and $\frac{3}{8}$" for Pattern "A", in order that the stringer can bear on the substringer.

Landing tread. The landing tread is made for the top of the stair. The thickness and the dimension of the nosing matches the standard tread. The section which overlaps the floor is made $\frac{3}{8}$" thick to fit resilient flooring combined with underlayment. A removable block can be inserted to increase the thickness to match $\frac{25}{32}$" wood flooring. See Figure 36.

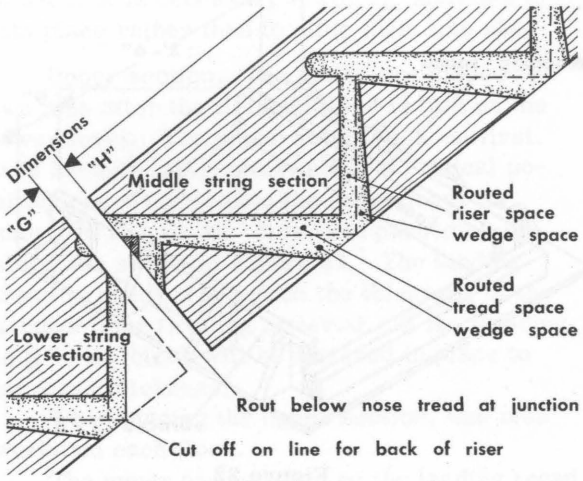

Figure 29

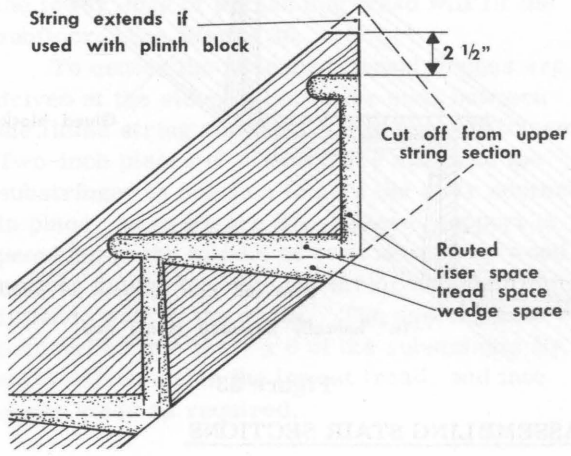

Figure 30

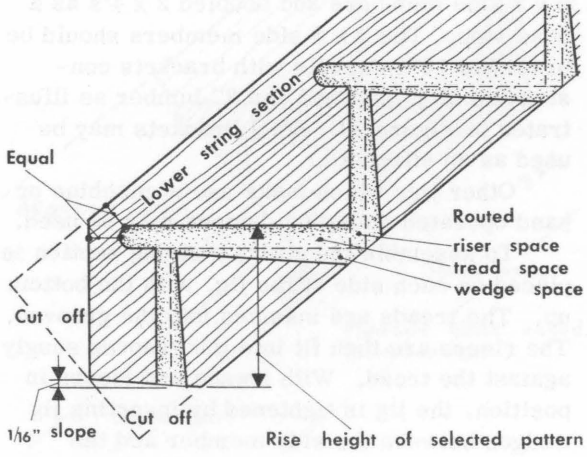

Figure 31

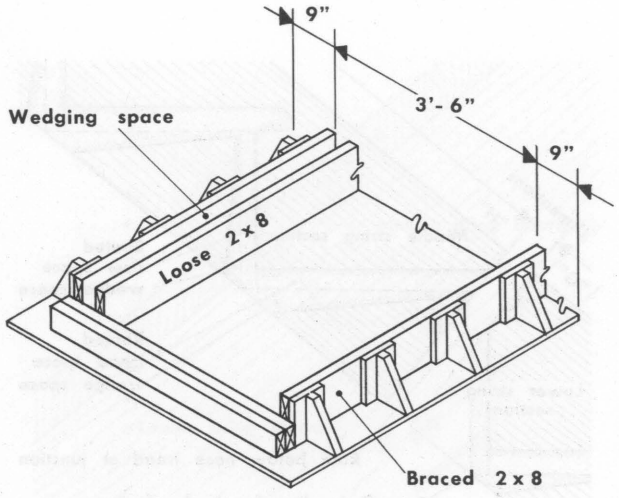

Figure 32

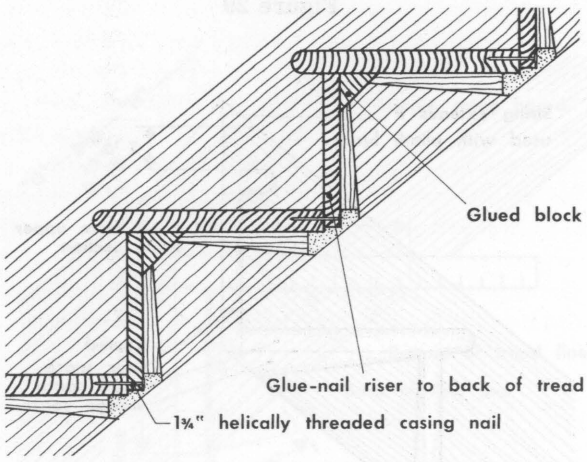

Figure 33

ASSEMBLING STAIR SECTIONS

The stair sections are assembled in a jig. A simple jig may be constructed by using a $\frac{3}{4}$" x 5' x 9' piece of plywood as a base with braced 2 x 8 side members and doubled 2 x 4's as a head stop. The 2 x 8 side members should be braced at 16" intervals with brackets constructed of $\frac{3}{4}$" plywood and 2" lumber as illustrated in Figure 32. Steel brackets may be used as an alternate.

Other jigs which make use of machine or hand operated clamping devices may be used.

To assemble the stair, a string section is placed on each side of the jig, with the bottom up. The treads are inserted into the grooves. The risers are then fit into the grooves snugly against the tread. With treads and risers in position, the jig is tightened by inserting jig wedges between the side member and the loose 2 x 8. Wood wedges are glued and driven into the routed space of the strings to force the treads and risers against the face of the routed groove.

Care must be taken in wedging the lower tread of the mid and upper sections in place to avoid driving the tread beyond its proper position.

Before the glue is allowed to set, the square of the assembly is checked and the lower portion of each riser is nailed into the back edge of each tread with $1\frac{3}{4}$" helically threaded casing nails.

The uppermost riser of each section fits into the rabbet in the end of the string section. This riser is also back-nailed into the string. Glue blocks are set in place between the treads and risers as shown in Figure 33.

Blocks of $\frac{1}{4}$" plywood must be attached to the back of the top riser of the upper section at the lower corners as shown in Figure 36. These will project to fit against the header and guide the proper placement of the stair section.

The whole assembly is then braced with $\frac{3}{8}$" x 1" plywood-strip cross braces after which the assembly may be carefully removed from the jig, turned over, and any excess glue removed.

Once the glue has set, cove molds are nailed under the nose of all treads which are assembled above risers. No cove is applied below the bottom tread of each stair section until the field operation.

Steel alignment plates $\frac{1}{8}$" x 1" x 4" are screwed to the outside of each finish string at the lower end. These plates project 2" beyond the face of the string cut, and guide the stair assemblies into alignment during placement. See Figure 37.

The stair assembly should be protected with rugged paper or fabric which can be left in place as a walking surface during finish construction.

INSTALLATION OF STAIR

Installation with Adhesive

High quality installation practice requires in addition to the nailing described below the use of a mastic-type construction adhesive for joining the stair sections to the substringer. The adhesive should be applied on the top edge of the 2 x 4 portion of the substringer immediately before the installation of each section of the stair. A caulking gun may serve as a simple type of applicator. When the adhesive

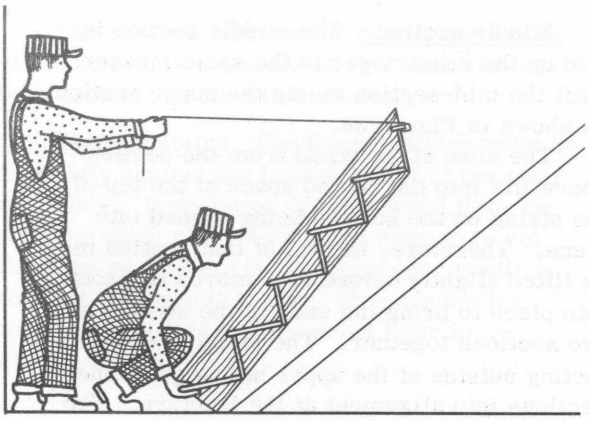

Figure 34

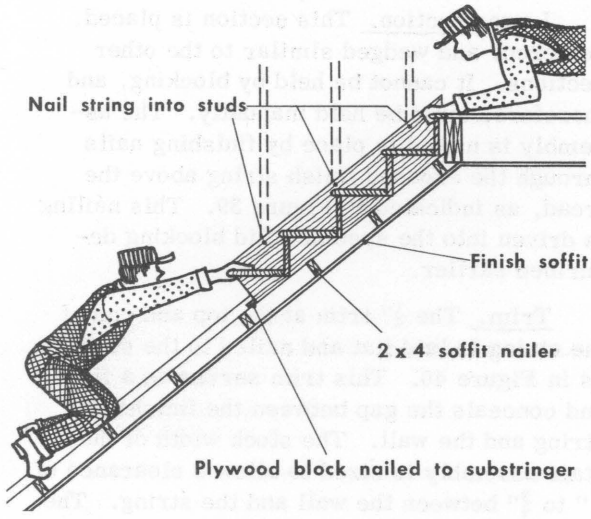

Figure 35

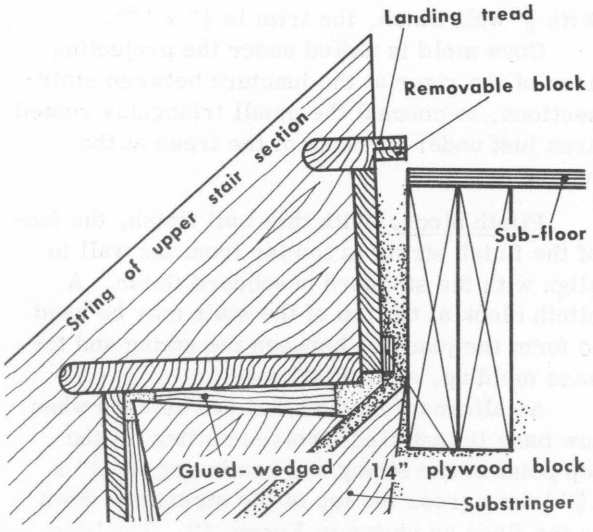

Figure 36

is used, it is necessary to lift the stair sections into place rather than to slide them into place.

Upper section. The stairs are placed by two men after the finished floor is laid on the lower level. The upper stair is placed first. It is brought to the stairwell in a vertical position and lowered onto the substringer as shown in Figure 34. It is then pushed up the slope, as shown in Figure 35. The landing tread is checked to match the thickness of the second-floor flooring material. If the flooring is $\frac{25}{32}$", the block will be fastened in place to increase thickness.

When placing the upper section, one man works on each floor.

The upper end is lifted so the landing tread will hook over the subfloor. The assembly is adjusted so the projecting blocks on the back of the assembly will fit against the header, and the lower edge of the landing tread will fit the subfloor. See Figure 36.

To center the assembly, wood wedges are driven at the sides of the lower ends between the finish string and the 1 x 6 of the substringer. Two-inch pieces of plywood are nailed to the substringer in position to hold the stair section in place, as in Figure 37. Lateral support is provided in the middle of each section by wood wedges driven between the string and the finished wall at the studs. The assembly is then nailed into the 1 x 6 of the substringer by nails driven under the lowest tread, and into upper studs as required.

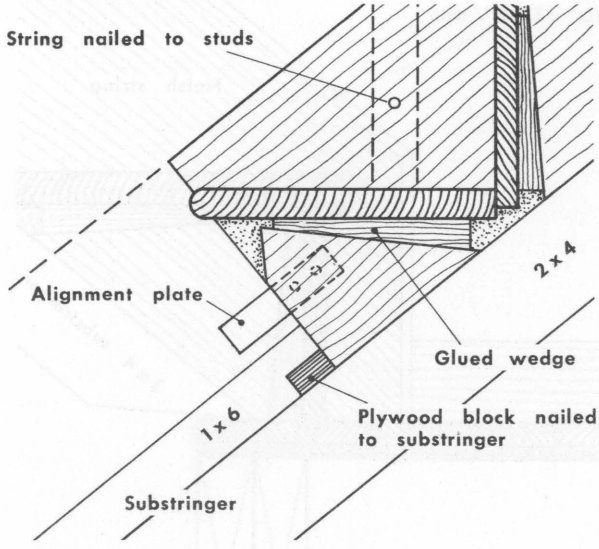

Figure 37

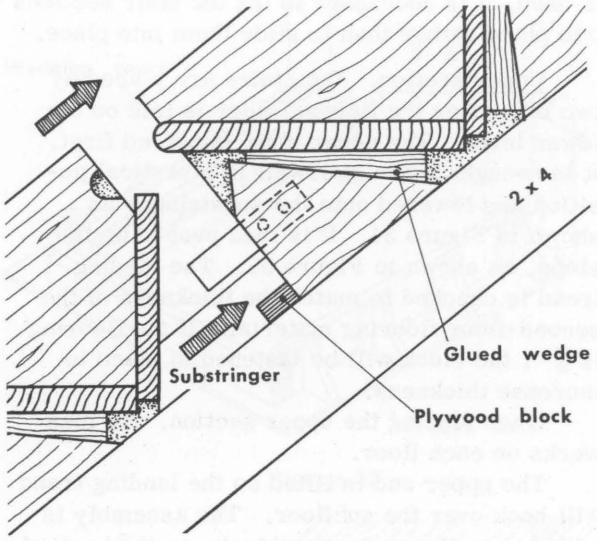

Figure 38

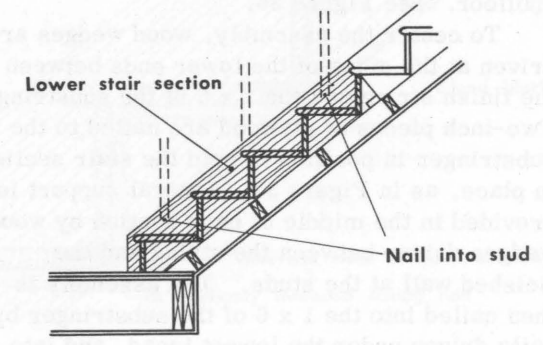

Figure 39

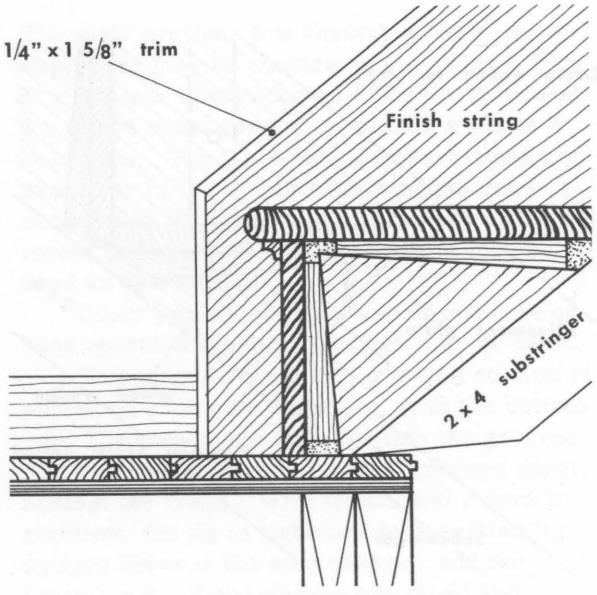

Figure 40

Middle section. The middle section is slid up the substringer in the same manner, until the mid-section meets the upper section, as shown in Figure 38.

The nose of the tread from the section above fits into the routed space at the top of the string on the section being pushed into place. Therefore, the top of that section must be lifted slightly before it is moved horizontally into place to bring the ends of the strings of the two sections together. The metal plates projecting outside of the upper string guide the sections into alignment at the juncture. The lower end is blocked, wedged, and nailed in the same manner described for the upper section.

Lower section. This section is placed, centered, and wedged similar to the other sections. It cannot be held by blocking, and therefore, must be held manually. The assembly is nailed in place by finishing nails through the exposed finish string above the tread, as indicated in Figure 39. This nailing is driven into the special solid blocking described earlier.

Trim. The $\frac{1}{4}$" trim at the top and end of the string is laid flat and nailed to the string, as in Figure 40. This trim serves as a finish and conceals the gap between the finished string and the wall. The stock width of the stair assembly is sized to allow a clearance of $\frac{3}{16}$" to $\frac{3}{4}$" between the wall and the string. The width of this gap depends on the thickness of the finish material on the wall, and the width of the trim depends on the width of this gap. With $\frac{3}{8}$" wall finish, the trim is $\frac{1}{4}$" x $1\frac{5}{8}$".

Cove mold is nailed under the projecting nose of the riser at the juncture between stair sections, to conceal the small triangular routed area just under the nose of the tread at the juncture.

Plinth block. With thin wall finish, the face of the finish string is too far from the wall to align with the standard baseboard finish. A plinth block at the top of the stair may be used to form the juncture between the string and the base molding, as in Figure 41.

An alternate method that can be used when low base is installed involves cutting off the top point of the string and continuing the $\frac{1}{4}$" x $1\frac{5}{8}$" trim across the top of the string and down to the floor as shown in Figure 42. The base can then be butted against this trim.

The vertical trim on the face of the string at the bottom of the stair can be joined to the base molding in the same manner.

Floor upstairs. The floor upstairs must be fit snugly against the landing tread of the stair assembly. Installation of the second floor before the stair requires special caution to set the edge of the flooring in the proper position to meet the landing tread. This connection will be simplified if the second floor is installed after the stair.

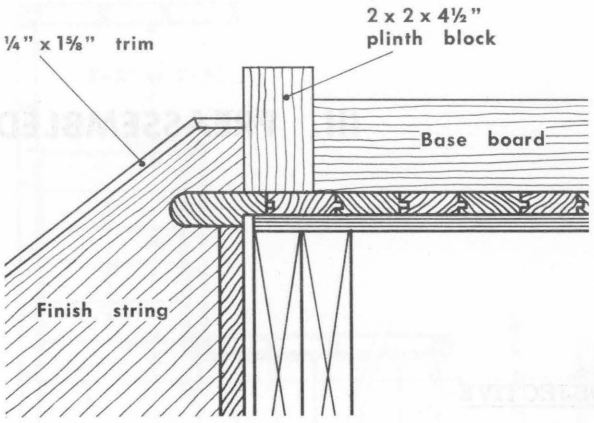

Figure 41

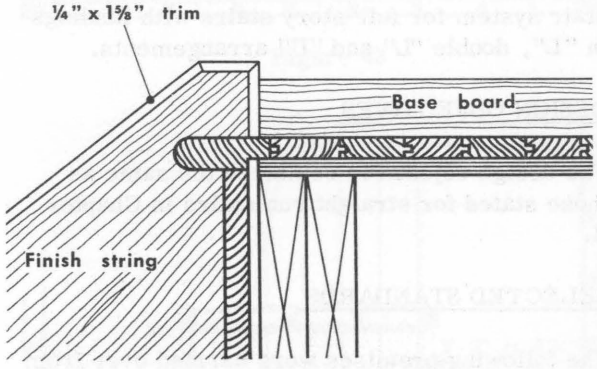

Figure 42

III. PREASSEMBLED LANDING STAIRS

OBJECTIVE

The objective of this portion of the study was to develop a method utilizing the preassembled stair system for full-story stairs with landings in "L", double "L" and "U" arrangements.

DESIGN OBJECTIVES

The design objectives remained the same as those stated for straight run stairs in Chapter II.

SELECTED STANDARDS

The following premises were carried over from the first part of the study.

Architectural Form

The preassembled stair is a closed-string, closed-riser type.

Structural Type

A housed-string structural type is used.

Dimensional Standards

Dimensional Standards for Width, Headroom, Run, Nosing, Standard Tread, and Rise remain the same as for the straight-run stair.

ADDED LIMITATIONS

To the above premises, three further limitations were added.

a) No flight shall be less than two risers.
b) No single flight shall exceed 12 risers.
c) The face of the first riser below and the first riser above the landing of a "U" stair shall be in the same plane.

DEVELOPED SYSTEM

Considering the objectives previously stated, the system was developed to permit the installation of the stair after the finish wall materials have been applied.

Stair Flights and Sections

Landing stairs, by definition, consist of two or more flights. In developing the system it was assumed that: 1) Flights from 2 to 6 risers would be built with a single section*, and 2) Flights of from 7 to 12 risers would be built in two sections.

Substringer

The design of the substringer remains the same.

Blocking for Soffit Finish

When required, blocking for the soffit finish may be provided in the same manner described for the straight-run stair.

DERIVED DIMENSIONS

Considering the selected standards and the varying flight lengths, the following details and dimensions were derived:

Total Run of Flight (finish-to-finish) for Layout

The finish flight must be planned for more than $9\frac{1}{2}$" per tread as extra space will be needed if the selected pattern must be tilted slightly to fit the floor-to-floor height. For total run of flight, see Dimension R, Table IV.

* This is the maximum size that can be moved into position through a door beside a landing at the foot of a stair.

Face of Bottom Riser to Plumb Line from Framing at Top of Flight

The standard position for the framing at the top of a flight is 1" behind the face of the riser. Therefore the dimension from the face of the bottom finish riser to the framing at the top of the flight is Dimension R plus 1", Figure 46.

Opening Length on Second Floor over First Flight

The framing on the second floor should be spaced to allow adequate headroom over the main stair. The length is given as Dimension K in Table V. See Figure 45.

Framing below Foot of the First (Lowest) Flight

If a basement stair is to be located below the primary stair the opening below the stair must be framed so as to receive the stair above. Framing below the foot of the first flight should be located at least $6\frac{1}{2}$" behind the face of the first riser.

Inside Corner Framing at Head of Flight

Inside corner framing must be placed 3" beyond the face of the top riser of the flight.

Inside Corner Framing at Foot of Flight

Inside corner framing must be placed 3" in front of the face of the lowest riser of the flight.

Clearance at Landings and Foot of Stair

In order to provide adequate space at landings or at the foot of each flight, the minimum dimension to the wall framing opposite the first and last risers of a flight, measured perpendicularly from the face of the riser, must be equal to the rough width of stair plus 3 inches.

PLANNING STAGE

1. Select stair width (3'-2" or 3'-6" rough framing width.)
2. Determine finish-floor-to-finish-floor height.
3. Select stair pattern and riser count of full stair, from Table III.
4. Select stair plan arrangement ("L", "U", etc.)

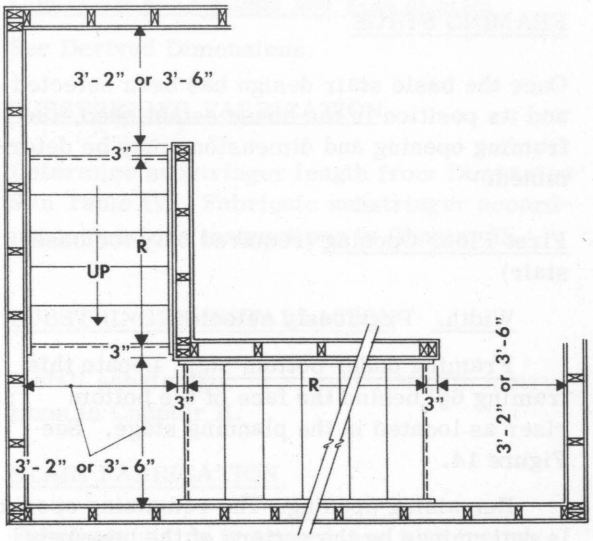

Figure 43

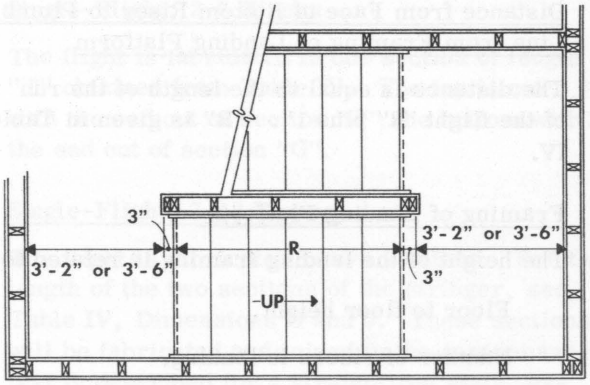

Figure 44

5. Layout
   a) landing space at foot and head of stair
   b) landings

For layout purposes, the dimension of a landing (or landing space) measured perpendicular to the face of the adjacent riser is equal to framing width of the stair (3'-2" or 3'-6") plus 3". This has the effect of making the landing for an "L" stair take the form of a short, equal-legged "L" with the leg dimension in each direction equal to W + 3". (The added 3" distance provides the necessary space for the wall framing and trim required at the head and foot of each flight.) See Figure 43.

6. For each flight, determine
   a) number of risers
   b) run of each flight

and plan stair accordingly. See Figure 44 for "U" landing stairs.

FRAMING STAGE

Once the basic stair design has been selected and its position in the house established, the framing opening and dimensions may be determined.

First Floor Opening (required only for base-stair)

Width. Previously selected.

Framing under bottom step. Locate this framing $6\frac{1}{2}$" behind the face of the bottom riser as located in the planning stage. See Figure 14.

Remaining opening. The remaining opening is determined by the pattern of the basement stair.

Distance from Face of Bottom Riser to Plumb Line from Framing of Landing Platform

The distance is equal to the length of the run of the flight "R" plus 1". "R" is given in Table IV.

Framing of Landing Platform

The height of the landing framing is related to:

Floor to floor height,

Number of risers to landing,

Subfloor thickness (floor and landing), and

Finish floor thickness (floor and landing).

To determine the height of the landing framing: Determine the actual height per rise by dividing the floor-to-floor height by the total number of risers. Multiply the individual rise height by the number of risers to the landing. If the subfloor and finish flooring for the first floor and the landing are the same, the height calculated above is the distance from the top of the floor framing to the top of the landing framing. If there is a difference in subfloor or flooring thickness, the height of the framing must be adjusted accordingly.

Platform Shape

The framing of the platform is patterned after the framing at the head and foot of a full-run stair. The basic length of landing platform is a dimension equal to the framing width of the stair. On the descending side of the landing, the framing is extended 2" by blocking out a 2 x 8 in front of the platform edge. On the ascending side, the platform is extended $9\frac{1}{2}$" beyond the basic dimension. See Figures 45, 46, 47, and 48.

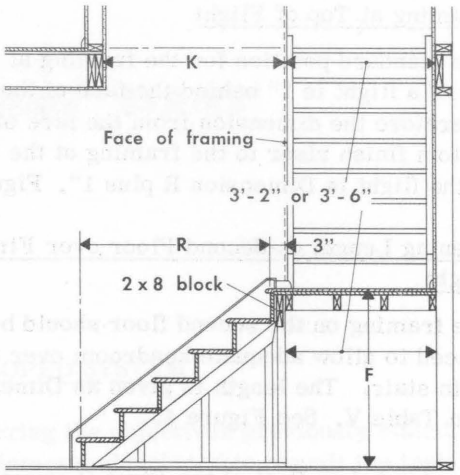

Figure 45

Second Floor Opening

Framing at top of stair. The framing at the top of an "L" type stair is illustrated in Figure 49.

Framing over first flight. See Figures 45 and 49 and Dimension "K" in Table V for the location of framing to allow necessary stair well clearances.

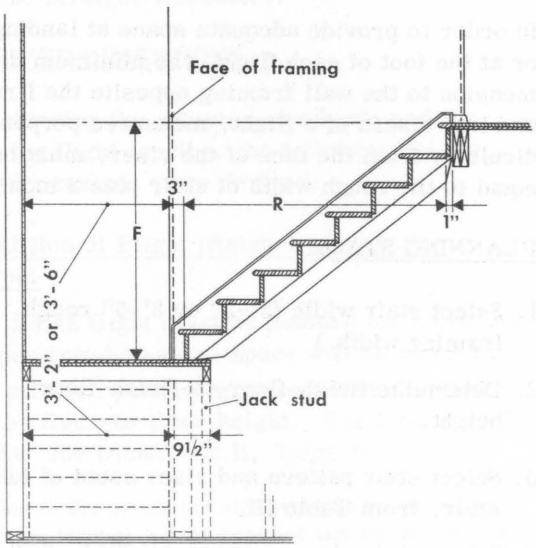

Figure 46

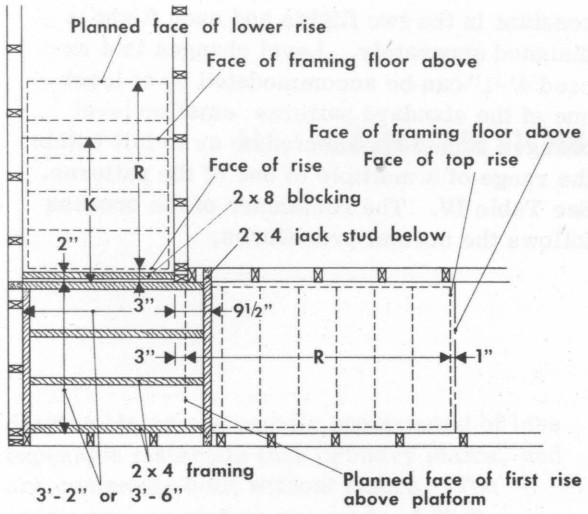

Figure 47

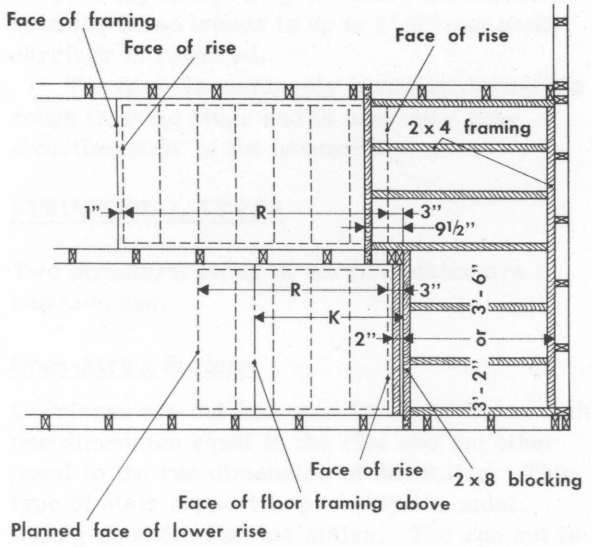

Figure 48

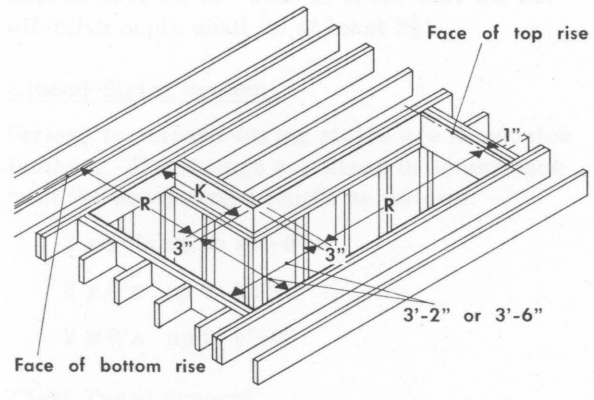

Figure 49

Clearance at Landings and Foot of Stair

See Derived Dimensions.

SUBSTRINGER FABRICATION

Determine substringer length from Dimension S in Table IV. Fabricate substringer according to previous instructions in Chapter II.

SUBSTRINGER INSTALLATION

Install substringer in accordance with instructions in Chapter II.

STAIR FABRICATION

Fabricate stairs in accordance with instructions given in Chapter II.

Single-Flight, 2-6 Risers

The flight is fabricated in one section of length "T" obtained from Table IV. The top is cut with the end cut of section "J"; the bottom with the end cut of section "G".

Single-Flight, 7-12 Risers

The flight is fabricated in two sections. For the length of the two sections of the stringer, see Table IV, Dimensions G and J. These sections will be fabricated and joined in the same manner that is described for a straight run stair, except there will be no center section.

Stairways for split-level or staggered-level houses, where the level change is less than a full story, may be disigned in two ways.

Method I

In some instances, it may be desirable to maintain the same riser height in both the lower-to-mid-level flight and mid-to-upper-level flight. In this case, the floor-to-floor height is determined from lower level to upper level, and the number of risers and the riser pattern selected in the normal manner. The total stair rise is then divided into two flights so as to accommodate the mid-level. To achieve the uniform rise height throughout the stair, the mid-level must be adjusted to a multiple of the height of the rise. Such an adjustment may be difficult to accomplish with some construction systems.

Once the basic layout has been determined, the detail planning, substringer fabrication, substringer installation, stair fabrication, and stair installation follows the procedures outlined for landing stairs, with the mid-level being considered the landing.

Method II

In the second method, the rise is not held constant in the two flights and each flight is disigned separately. Level changes that exceed 4'-1" can be accommodated by at least one of the standard patterns; smaller level changes should be selected so as to fall within the range of a multiple of one of the patterns. See Table IV. The remainder of the process follows the normal procedures.

IV. CONVENTIONAL SERVICE STAIRS

Service stairs are usually constructed of less expensive materials than primary stairs, and are commonly built without risers. The carriages or strings are made of 2" dimension lumber, and the treads are normally 2 x 10's ($1\frac{1}{2}$ or $1\frac{5}{8}$" x $9\frac{1}{2}$"). Since the allowable span for these treads is up to 3'-6", no center carriage is required.

The stair is commonly installed during the rough framing stage and is used as a construction stair to the basement.

STRUCTURAL TYPES

Two structural types of service stairs are in common use.

Open-String System

Carriages are cut in a saw-toothed pattern with one dimension equal to the rise and the other equal to the run dimension of the stairs. This type of stair support is probably the most widely used for service stairs. The run cut is $\frac{1}{2}$" shorter than the tread width to allow a $\frac{1}{2}$" overhang. The treads are face nailed to the carriage. The carriage must be cut from boards at least 10" wide in order that the net effective depth shall be at least $3\frac{1}{2}$".

Closed-String System

Strings for closed-string stairs are dimension lumber. The strings are sized in accordance with the unsupported length as follows:

2 x 10's up to 13'-0"

2 x 8's up to 12'-0"

2 x 6's up to 9'-0"

Cleat Tread Support

Treads can be fastened by wood cleats to full depth strings. Cleats of 1 x 3 material are normally used, and the treads are fastened by end nailing through the strings.

Groove Tread Support

Grooves $\frac{3}{8}$" deep may be cut into the sides of the string for support of the treads. The treads are secured by end-nailing through the string. The grooves can be cut by a radial arm saw with a dado head.

Bottom Connection

When the stair is installed before the basement slab, the lower end of the carriage or string may be temporarily supported by masonry blocking or it may be hung with wood boards that are fastened to the floor framing above.

The lower end of the carriage or string may rest on a raised platform of concrete in order to protect it from moisture. This raised platform may be a full step high and extend in front of the stair to provide the first step, or it may be lower and not serve as a step.

The lateral force of the load on the stair is usually resisted by a 2 x 4 kick plate anchored to the floor or to the raised platform.

Top Connection

The upper end of the carriages or strings may be extended to bear against floor framing at the head of the stair or may be hung with metal or plywood supports fastened to the framing.

If the carriages or strings are extended to bear on the floor framing at the top of the stair, the subfloor overlaps the stair framing and is supported by 2 x 4 blocking installed between carriages or strings. Ordinarily this method requires that the carriages or strings be installed before the subfloor.

When the carriage or string is supported by metal or plywood attachments at the top of the

stair, the subfloor may be installed independently of the stair installation.

FLOOR-TO-FLOOR HEIGHT

Basement-floor-to-first-floor heights vary with the heights of the foundation wall, the size of the floor joists, the first floor subfloor and finish flooring, and the basement flooring.

The minimum ceiling height between basement floor and the bottom of the floor joists is specified as 6'-9" in the MPS, but spaces that are to be used as work rooms and recreation areas are normally about 7'-6" or higher. Accordingly, normal floor-to-floor dimensions are 8'-2$\frac{5}{16}$" and higher.

CODE REQUIREMENTS

The model building codes and the Minimum Property Standards specify some dimensional requirements for service stairs that are different than those for primary stairs. An overhang of $\frac{1}{2}$" is required for open rise stairs under the Minimum Property Standards and the BOCA code. With a closed riser, the primary stair requirements for nosing remain in effect.

The Minimum Property Standards require a minimum head room of 6'-4" for the service stairs as compared to 6'-8" for primary stairs. The minimum width for service stairs is 2'-6" as compared to 2'-8" for primary stairs. Requirements for width and headroom are the same for both service and primary stairs under the National and Uniform Building Codes.

Three other requirements which are the same for both the primary and the service stair govern the construction of carriages that are supported at the top and bottom only. The Minimum Property Standards require a net effective depth of at least 3$\frac{1}{2}$", a 2" minimum thickness for carriages (nominal) and a 4" minimum bearing at the top of the stairs.

STAIR PROPORTIONING

The same proportioning rules which were enumerated for the primary stairs are also valid for the selection of rise and run for the service stairs.

V. PREASSEMBLED SERVICE STAIRS

DESIGN OBJECTIVES

In order to make a preassembled service stair suitable for the largest number of houses with basements, it was developed to meet the following objectives:

1. Compliance insofar as possible with the Minimum Property Standards of the Federal Housing Administration and the Uniform Building Code, National Building Code, and Basic Building Code.

2. Installation in one piece during the rough-framing stage.

3. Coordination with primary stair.

4. A minimum number of parts.

SELECTED STANDARDS

To meet the requirements stated above, the following premises were established during the study:

Plan Arrangement

A straight stair was selected as being the most common acceptable type for service stair use.

Architectural Form

The service stair is designed so that it may be enclosed by a wall on one or both sides, or left open and used with railings.

Structural Type

An open-rise, closed-string stair is used with the treads fitting into and supported by grooves in one side of each string. The stair spans from floor-to-floor in one piece.

Dimensional Standards

Width:

For one handrail: rough framing opening 3'-2"; out-to-out of strings 3'-1$\frac{5}{8}$".

For two handrails: rough framing opening 3'-6"; out-to-out of strings 3'-5$\frac{5}{8}$".

The above dimensions allow a clearance of $\frac{3}{16}$" between the string and the rough framing on each side.

Headroom: Minimum Headroom 6'-8"

Run: Standard run 9"

Nosing: Standard nosing 1$\frac{1}{4}$"

Overhang: Standard overhang $\frac{1}{2}$"

Standard Tread: 9$\frac{1}{2}$": (from 2 x 10 lumber)

Rise: Standard riser pattern "c" 7$\frac{5}{8}$"

"d" 7$\frac{7}{8}$"

"e" 8$\frac{1}{8}$"

EXPLANATION OF SELECTED STANDARDS

Width

The rough framing width was selected to be consistent with the widths of the preassembled primary stair system recommended in Chapter II. If the enclosing walls of the stair well are finished, the net width will be less.

Headroom

The minimum headroom of 6'-8" complies with the codes considered in the study.

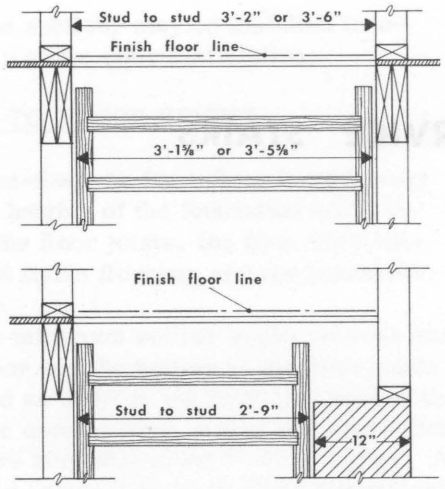

Figure 50

Standard Run, Tread, Overhang and Nosing

The stair patterns were established with a run dimension of 9" and a overhang of $\frac{1}{2}$" to satisfy code requirements. The tread width, $9\frac{1}{2}$", is the standard dimension for nominal 10" wide lumber. It is assumed that the treads will be 2 x 10's ($1\frac{1}{2}$ x $9\frac{1}{2}$"). The $1\frac{1}{4}$" nosing is needed at the top riser which is closed due to the framing construction.

Standard Rise

Two of the rise heights, $7\frac{5}{8}$" and $7\frac{7}{8}$", were established to match the primary stair dimensions. The third height, $8\frac{1}{8}$", was adopted for service stairs only. The latter height was established to permit a 13-riser stair to service a wider range of floor-to-floor heights. Using the three patterns with the permissible tilt of plus or minus $\frac{1}{8}$" per riser, thirteen risers cover floor-to-floor heights ranging from 8'-$1\frac{1}{2}$" to 8'-$11\frac{1}{4}$".

Since the service stair run dimensions are different than those established for the primary stair, the patterns are identified differently. Service stair patterns are designated by lower case letters.

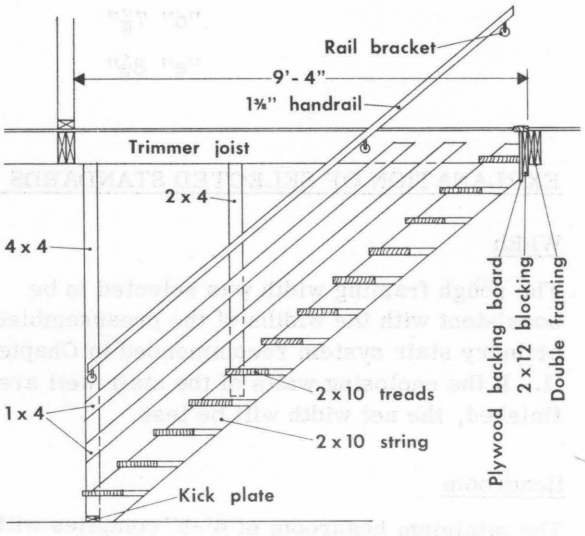

Figure 51

DEVELOPED SYSTEM

In accordance with the objectives previously stated, the system was developed to permit the entire stair to be installed during the rough framing stage. See Figure 51.

Stair Structure

The strings of the 13-riser stair are 2 x 10 members routed to receive the 2 x 10 treads.

Stair Connection at Head

The stair is connected at the head by means of a hinged plywood hanger. Hinging the hanger permits easy adjustment of the stair to different slopes; it also allows the stair to be lifted while the basement floor is placed.

Special Landing Tread and Blocking Sub-assembly

A special landing tread and blocking subassembly is used for positioning the stair, and to provide bearing for the stair hanger. See Figure 52.

Kick Plate

The lower end of the stair is secured against

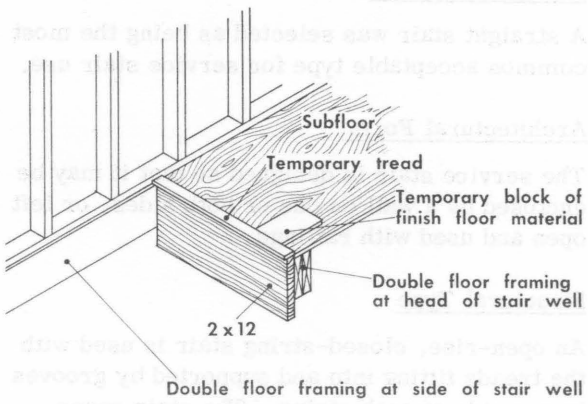

Figure 52

horizontal thrust by a 2 x 4 kick plate which is installed after the basement floor is in place.

DERIVED DIMENSIONS

Length of Opening in Floor Framing

The length of the opening in the floor framing at the first(upper) floor should be sufficient to allow room for the stair connection construction and for headroom above the service stair. For 12-and 13-rise service stairs, this dimension is 9'-4". See Table I and Figure 53.

Total Run of Stair

The total run of the stairs is equivalent to 9 inches per tread plus 2 inches. The added 2 inches provides for the increased run that may occur due to tilting the stair for adjustment.

PLANNING STAGE

The following is a description of the planning procedure for a straight-run service stair.

Select Stair Width

The width of a service stair built below a primary stair will be controlled by the width of the primary stair. Standard framing widths are 3'-2" (one handrail) and 3'-6" (two handrails). Caution: Service stairs built against basement walls may have to be narrower than stairs above due to the extra thickness of the basement walls. handrails). See Figure 50.

Determine Finish-Floor-to-Finish-Floor Height

Select Stair Pattern and Riser Count

After the floor-to-floor height is determined, select the stair pattern and riser count from Table VI.

Determine Stair Run Length "r"

Determine Dimension "r" from Table VI and use this dimension to lay out the total run of the stair. (Since there are no risers, run dimensions are measured from the front edge of the treads.)

Edge of Landing Tread

The position of the service stair is partially controlled by the necessity of providing adequate headroom under the framing supporting the primary stair above. To provide this clearance the edge of the landing tread at the top of the service stair must be located a minimum of 9'-7" behind the face of the first riser of the primary stair.

Clearance at Foot of Stair

Lay out stair so as to provide a minimum clearance of 3'-2" or 3'-6" in front of the edge of the lowest tread, same as stair width selected.

Clearance at Head of Stair

Provide a similar minimum clearance at the head of the stair. If there is a door at the top of the stair, provide the clearance beyond the wall framing of the doors.

FRAMING STAGE - FIRST FLOOR OPENING

Width

Frame the rough opening to the width previously selected.

Framing at Head of Stair

Locate the floor framing at the head of the stair a distance of $3\frac{5}{8}$" back of the front edge of the landing tread as located in the planning stage. (This framing is located at least 9'-$10\frac{1}{2}$" from the face of the first riser of the primary stair above.)

Length of First Floor Framing Opening

The length of the opening in the first floor framing is 9'-4".

STAIR FABRICATION

Special Landing Tread and Blocking Subassembly

This unit consists of 2 x 12's cut to a length equal to the width of the rough framing opening, to which a $1\frac{1}{16}$" x $3\frac{5}{8}$" special landing tread has been attached. The landing tread is nailed to the top edge of the 2 x 12 to form an L cross section, as shown in Figure 52. Since it will be subject to use during the house construction operation, it may be desirable to first use a temporary rough piece for the tread, replacing it later with the finish grade member. In this case the piece may be as narrow as $2\frac{3}{8}$", but the thickness must be $1\frac{1}{16}$". The service stair is made in the shop by assembling precut standard strings and treads.

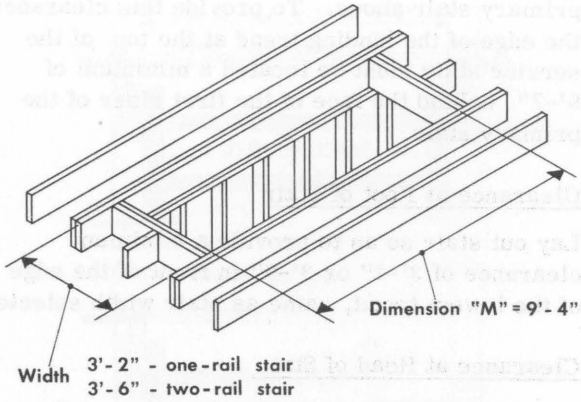

Figure 53

10 inches from one end of the piece, as shown in Figure 54. The line of slope of the top of the tread is marked with a carpenter's square with the 9-inch run dimension measured from point "t" and the selected rise dimension measured from the same edge of the string.

The groove for this step is dadoed with a radial arm saw adjusted to cut to the angle marked. See Figure 55.

Keeping the string in the same position, attach a Hy-Board to the fence of the saw as shown in Figure 55. Mark point "u" on the string at the furthest Hy-line.

The 2 x 10 string is then moved so that point "u" aligns with the next mark on the Hy-

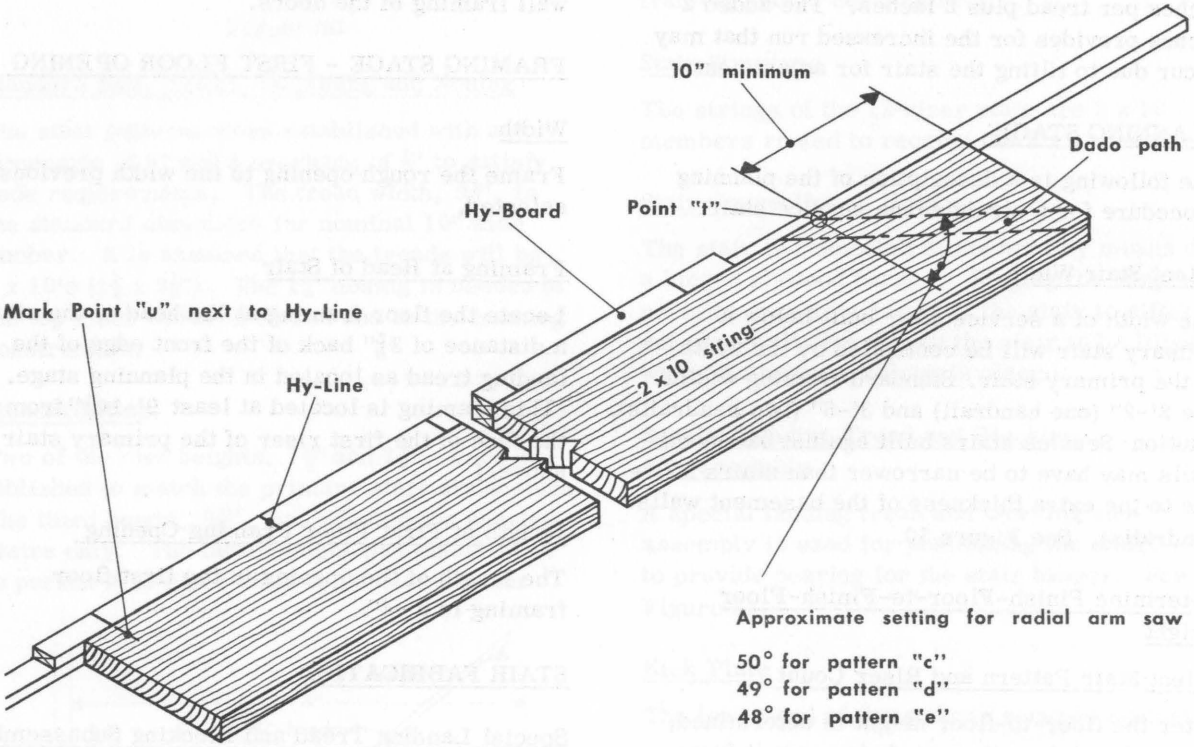

Figure 54

Strings

Standard strings are made from 14-foot lengths of 2 x 10 material. Strings are dadoed with grooves $1\frac{1}{2}$" wide and $\frac{3}{8}$" deep to receive the treads. The grooves are on the same slope as the treads and are spaced to match the selected rise system. Strings must be made in right and left hand patterns.

Dadoing String

In preparing for the dadoing process, point 't'. is marked on one edge of the 2 x 10 at least

Board (See Table VII for hypotenuse dimensions) and the next groove is dadoed. See Figure 56

Top Cut

The top horizontal end cut is made parallel to the tread as shown in Figure 57. The sloping end cut is also made as shown in Figure 57.

Bottom Cut

The bottom end cuts are made parallel and perpendicular to the tread as shown in Figure 58. The string is also notched to fit over the 2 x 4 kick plate.

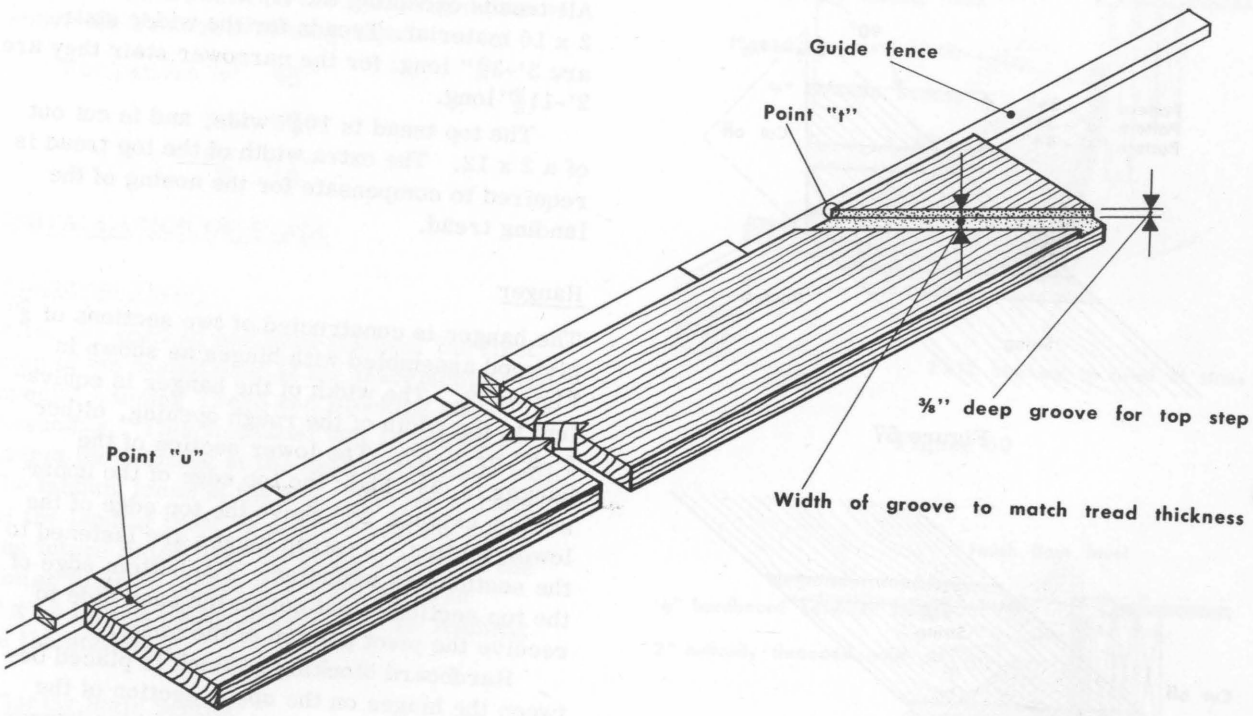

Figure 55

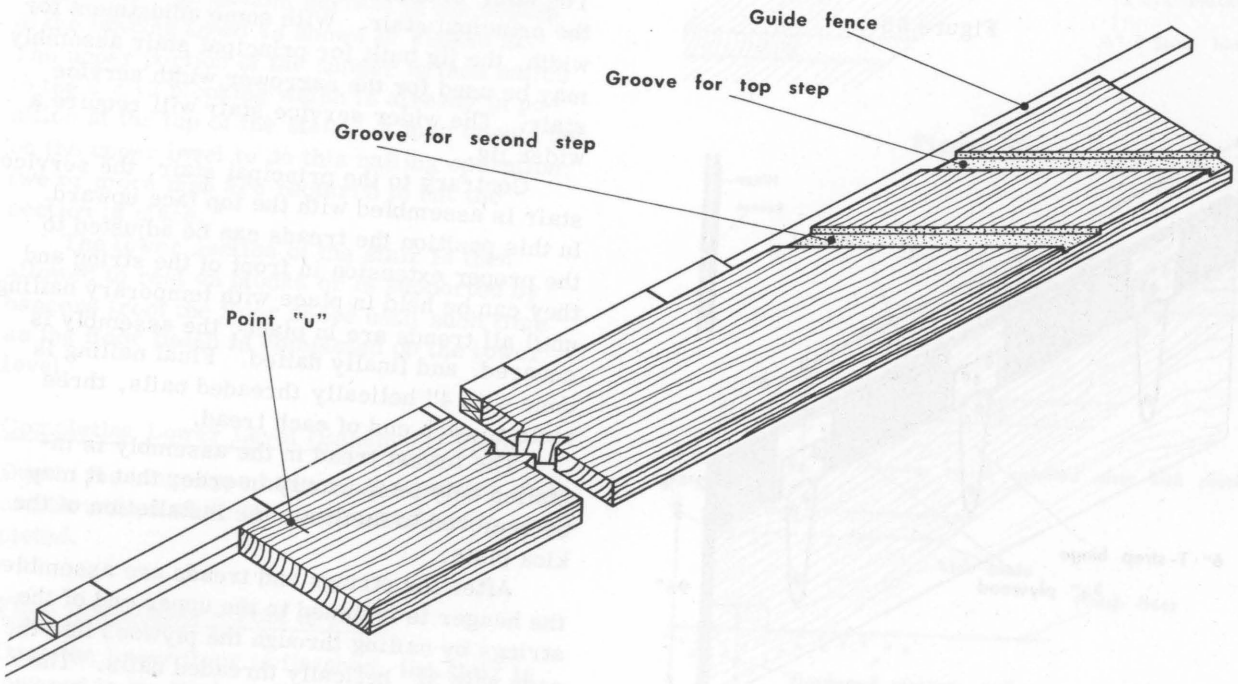

Figure 56

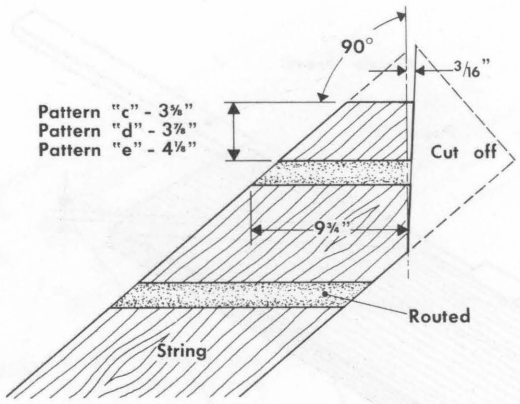

Figure 57

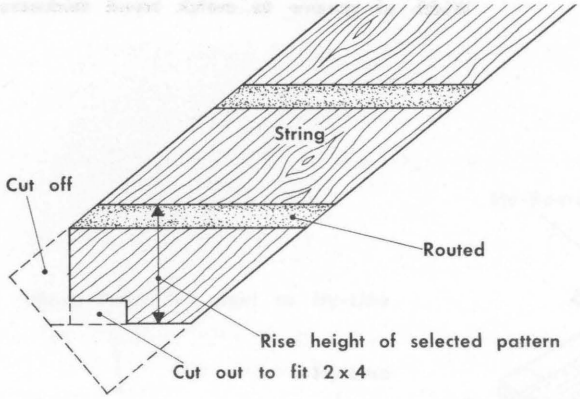

Figure 58

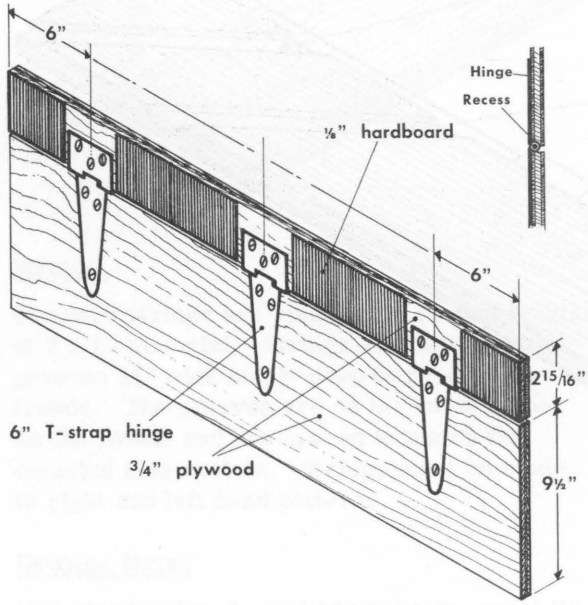

Figure 59

Treads

All treads excepting the top tread are cut from 2 x 10 material. Treads for the wider stair are 3'-3⅜" long; for the narrower stair they are 2'-11⅜" long.

The top tread is 10¼" wide, and is cut out of a 2 x 12. The extra width of the top tread is required to compensate for the nosing of the landing tread.

Hanger

The hanger is constructed of two sections of ¾" plywood assembled with hinges as shown in Figure 59. The width of the hanger is equivalent to the width of the rough opening, either 3'-2" or 3'-6". The lower section of the hanger is 9½" high; the top edge of the upper section extends 2 15/16" above the top edge of the lower section. T-strap hinges are fastened to the sections as indicated. The bottom edge of the top section is cut out on the back side to receive the pivot portion of the hinge.

Hardboard blocking ⅛" thick is placed between the hinges on the upper section of the hanger in order that when installed the hanger can bear properly against the adjacent framing without interference from the hinges.

Stair Assembly

The stair is assembled in a manner similar to the principal stair. With some adjustment for width, the jig built for principal stair assembly may be used for the narrower width service stair. The wider service stair will require a wider jig.

Contrary to the principal stair, the service stair is assembled with the top face upward. In this position the treads can be adjusted to the proper extension in front of the string and they can be held in place with temporary nailing until all treads are in place, the assembly is squared, and finally nailed. Final nailing is done with 4" helically threaded nails, three nails to each end of each tread.

The lowest tread in the assembly is installed only temporarily in order that it may be removed to facilitate the installation of the kick plate.

After the strings and treads are assembled, the hanger is fastened to the upper end of the strings by nailing through the plywood into the ends with 3½" helically threaded nails. The hanger is also nailed to the back edge of the top tread.

The top edge of the top section of the hanger must be located the following distance above the surface of the top tread:

For pattern "c" $6\frac{9}{16}$"

" "d" $6\frac{13}{16}$"

" "e" $7\frac{1}{16}$"

INSTALLATION OF STAIR

Alignment Tread

After the opening has been framed, the first step of the installation is the placement of the Special Landing Tread and Blocking sub-assembly. This L-shaped unit is placed against the framing at the head of the stair with the landing tread at the top. The top surface of the landing tread is aligned with the top of the future finish floor by using a piece of the finish floor as shown in Figure 52. The 2 x 12 is then nailed securely to the framing of the stairwell.

Placing Stair Section

The stair section is lowered through the well and temporarily propped in place with the head one or two inches below the final position. See Figure 60. The head is then raised until the top edge of the top section of the hanger is in contact with the bottom surface of the nosing of the landing tread as shown in Figure 61. The upper portion of the hanger is then nailed to the 2 x 12 blocking which is already in position at the top of the stair. A man should be on the upper level to do this nailing operation; two or more men are required to lift the section in place.

The lower section of the stair is then allowed to rest on blocks or is supported by hangers from the floor above until such time as the floor finish is completed on the lower level.

Completing Lower Level (Basement) Floor

Due to the hinge-type hanger, the service stair can be raised while the basement floor is completed.

Final Installation - Foot of Stair

Once the lower floor is finished, the stair is lowered to its final position, and the lower tread is removed. The kick plate is fastened

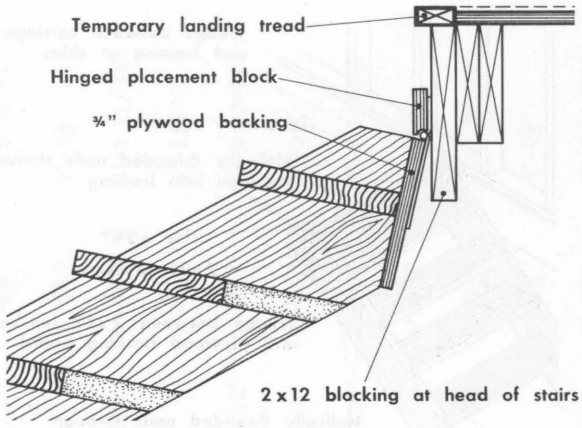

Figure 60

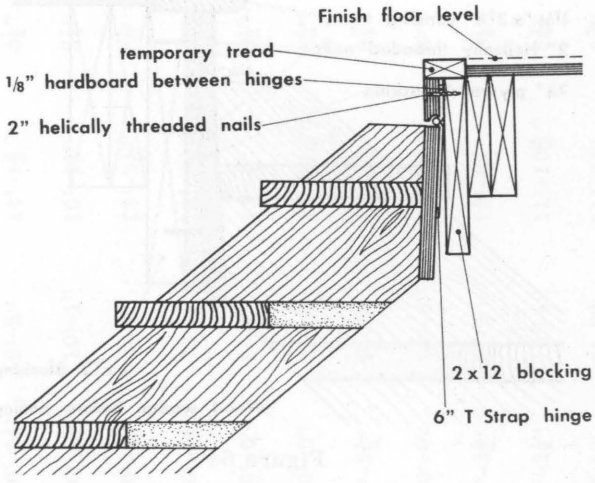

Figure 61

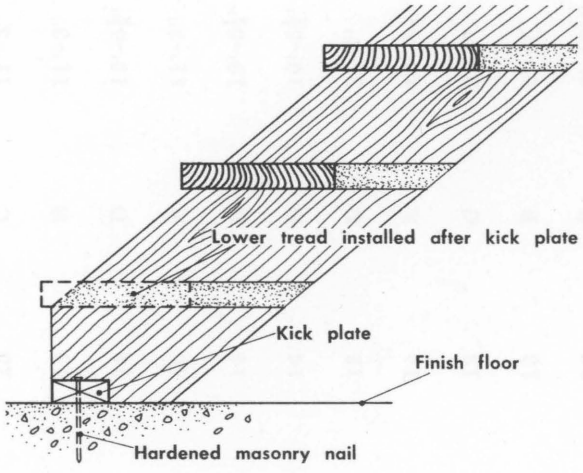

Figure 62

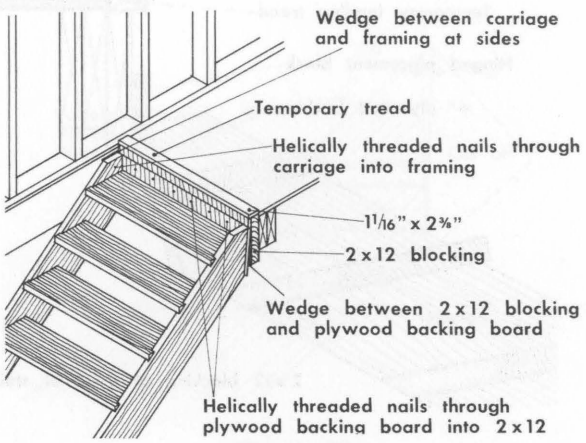

Figure 63

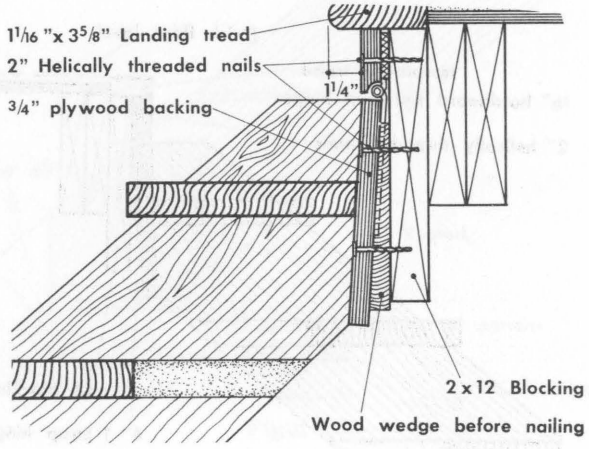

Figure 64

in place with hardened steel nails or a powder-actuated fastener, and the stair is fastened to it as shown in Figure 62. The lower tread is then replaced.

Head of Stair

At the head of the stair, shims are driven between the plywood hanger and the 2 x 12 blocking. The stair is permanently fastened in place by nailing through the lower part of the hanger into the bearing block. See Figure 63.

Landing Tread

If a temporary landing tread is used during the construction period, the final finish tread should be put in place at the time the finish flooring is installed. See Figure 64.

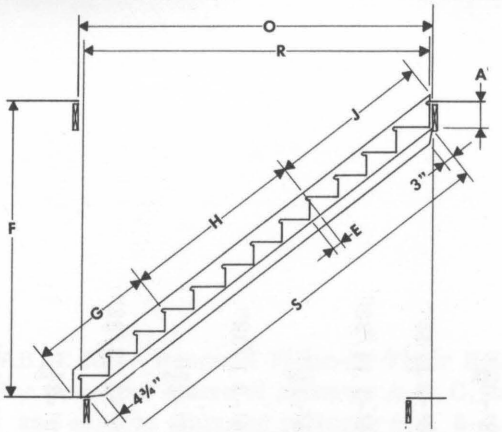

TABLE I -- Dimensions for straight run principal stairs

Floor to Floor Height		No. of Risers	Stair Pattern	Finish Dimension	Rough Framing Dimensions		Sub-stringer Dimensions		Finish Stringer Dimensions			
					L	O	S	A	E	G	H	J
9'-8¼"	10'-0"	15	D	11'-3"	10'-9½"	9'-6"	14'-3 7/16"	8¾"	4 7/32"	4'-7 9/16"	5'-1 11/16"	5'-5½"
9'-4½"	9'-8¼"	15	C	11'-3"	10'-9½"	9'-9"	14'-1 3/16"	8½"	3 31/32"	4'-6 13/16"	5'-0 29/32"	5'-4⅝"
9'-0¾"	9'-4½"	15	B	11'-3"	10'-9½"	10'-1"	13'-11"	8¼"	3 11/16"	4'-6 1/16"	5'-0⅛"	5'-3⅞"
9'-0½"	9'-4"	14	D	10'-5½"	10'-0"	9'-6"	13'-3 1/16"	8¾"	4 7/32"	4'-7 9/16"	4'-1 11/32"	5'-5½"
8'-9"	9'-0¾"	15	A	11'-3"	10'-9½"	10'-6"	13'-8 13/16"	8"	3 7/16"	4'-5 5/16"	4'-11⅜"	5'-3⅛"
8'-9"	9'-0½"	14	C	10'-5½"	10'-0"	9'-9"	13'-1"	8½"	3 31/32"	4'-6 13/16"	4'-0 23/32"	5'-4⅝"
8'-5½"	8'-9"	14	B	10'-5½"	10'-0"	10'-1"	12'-11 15/16"	8¼"	3 11/16"	4'-6 1/16"	4'-0⅛"	5'-3⅞"
8'-4¾"	8'-8"	13	D	9'-8"	9'-2½"	9'-6"	12'-2¾"	8¾"	4 7/32"	4'-6 13/16"	4'-1 11/32"	4'-5⅛"
8'-2"	8'-5½"	14	A	10'-5½"	10'-0"	10'-6"	12'-8 15/16"	8"	3 7/16"	4'-5 5/16"	3'-11½"	5'-3⅛"
8'-1½"	8'-4¾"	13	C	9'-8"	9'-2½"	9'-9"	12'-0 13/16"	8½"	3 31/32"	4'-6 13/16"	4'-0 23/32"	4'-4½"
7'-10¼"	8'-1½"	13	B	9'-8"	9'-2½"	10'-1"	11'-10 15/16"	8¼"	3 11/16"	4'-6 1/16"	4'-0⅛"	4'-3⅞"
7'-9"	8'-0"	12	D	8'-10½"	8'-5"	9'-6"	11'-2⅜"	8¾"	4 7/32"	2'-6 7/8"	4'-1 11/32"	5'-5½"
7'-7"	7'-10¼"	13	A	9'-8"	9'-2½"	10'-6"	11'-9 1/16"	8"	3 7/16"	4'-5 5/16"	3'-11½"	4'-3¼"
7'-6"	7'-9"	12	C	8'-10½"	8'-5"	9'-9"	11'-0⅝"	8½"	3 31/32"	2'-6 7/16"	4'-0 23/32"	5'-4⅝"

TABLE II -- Length of Principal Stair Hypotenuse with $9\frac{1}{2}$" runs

Number of Treads	Pattern A Rise Height $7\frac{1}{8}$"	Pattern B Rise Height $7\frac{3}{8}$"	Pattern C Rise Height $7\frac{5}{8}$"	Pattern D Rise Height $7\frac{7}{8}$"
1	$11\frac{7}{8}$"	1'-0 1/32"	1'-$0\frac{3}{16}$"	1'-0 11/32"
2	1'-$11\frac{3}{4}$"	2'-$0\frac{1}{16}$"	2'-$0\frac{3}{8}$"	2'-$0\frac{11}{16}$"
3	2'-$11\frac{5}{8}$"	3'-0 3/32"	3'-0 17/32"	3'-1 1/32"
4	3'-$11\frac{1}{2}$"	4'-$0\frac{1}{8}$"	4'-0 23/32"	4'-1 11/32"
5	4'-$11\frac{3}{8}$"	5'-$0\frac{1}{8}$"	5'-0 29/32"	5'-$1\frac{11}{16}$"
6	5'-$11\frac{1}{4}$"	6'-0 5/32"	6'-1 3/32"	6'-2 1/32"
7	6'-$11\frac{1}{8}$"	7'-$0\frac{3}{16}$"	7'-1 9/32"	7'-$2\frac{3}{8}$"
8	7'-11"	8'-0 7/32"	8'-$1\frac{7}{16}$"	8'-2 23/32"
9	8'-$10\frac{7}{8}$"	9'-$0\frac{1}{4}$"	9'-$1\frac{5}{8}$"	9'-$3\frac{1}{16}$"
10	9'-$10\frac{3}{4}$"	10'-$0\frac{1}{4}$"	10'-$1\frac{13}{16}$"	10'-$3\frac{3}{8}$"
11	10'-$10\frac{5}{8}$"	11'-0 9/32"	11'-2"	11'-3 23/32"
12	11'-$10\frac{1}{2}$"	12'-$0\frac{5}{16}$"	12'-$2\frac{3}{16}$"	12'-$4\frac{1}{16}$"
13	12'-$10\frac{3}{8}$"	13'-0 11/32"	13'-2 11/32"	13'-4 13/32"
14	13'-$10\frac{1}{4}$"	14'-$0\frac{3}{8}$"	14'-2 17/32"	14'-$4\frac{3}{4}$"
15	14'-$10\frac{1}{8}$"	15'-0 13/32"	15'-2 23/32"	15'-5 3/32"

TABLE III -- Range of Floor-to-Floor Height
For principal stairs of patterns A, B, C, & D
and service stairs of patterns c, d, & e.

Number of Risers	Pattern A Riser Height $7\frac{1}{8}$"	Pattern B Riser Height $7\frac{3}{8}$"	Pattern C & c Riser Height $7\frac{5}{8}$"	Pattern D & d Riser Height $7\frac{7}{8}$"	Pattern e Riser Height $8\frac{1}{8}$"
7	4'-1" to 4'-$2\frac{3}{4}$"	4'-$2\frac{3}{4}$" to 4'-$4\frac{1}{2}$"	4'-$4\frac{1}{2}$" to 4'-$6\frac{1}{4}$"	4'-$6\frac{1}{4}$" to 4'-8"	4'-8" to 4'-$9\frac{3}{4}$"
8	4'-8" to 4'-10"	4'-10" to 5'-0"	5'-0" to 5'-2"	5'-2" to 5'-4"	5'-4" to 5'-6"
9	5'-3" to 5'-$5\frac{1}{4}$"	5'-$5\frac{1}{4}$" to 5'-$7\frac{1}{2}$"	5'-$7\frac{1}{2}$" to 5'-$9\frac{3}{4}$"	5'-$9\frac{3}{4}$" to 6'-0"	6'-0" to 6'-$2\frac{1}{4}$"
10	5'-10" to 6'-$0\frac{1}{2}$"	6'-$0\frac{1}{2}$" to 6'-3"	6'-3" to 6'-$5\frac{1}{2}$"	6'-$5\frac{1}{2}$" to 6'-8"	6'-8" to 6'-$10\frac{1}{2}$"
11	6'-5" to 6'-$7\frac{3}{4}$"	6'-$7\frac{3}{4}$" to 6'-$10\frac{1}{2}$"	6'-$10\frac{1}{2}$" to 7'-$1\frac{1}{4}$"	7'-$1\frac{1}{4}$" to 7'-4"	7'-4" to 7'-$6\frac{3}{4}$"
12	7'-0" to 7'-3"	7'-3" to 7'-6"	7'-6" to 7'-9"	7'-9" to 8'-0"	8'-0" to 8'-3"
13	7'-7" to 7'-$10\frac{1}{4}$"	7'-$10\frac{1}{4}$" to 8'-$1\frac{1}{2}$"	8'-$1\frac{1}{2}$" to 8'-$4\frac{3}{4}$"	8'-$4\frac{3}{4}$" to 8'-8"	8'-8" to 8'-$11\frac{1}{4}$"
14	8'-2" to 8'-$5\frac{1}{2}$"	8'-$5\frac{1}{2}$" to 8'-9"	8'-9" to 9'-$0\frac{1}{2}$"	9'-$0\frac{1}{2}$" to 9'-4"	9'-4" to 9'-$7\frac{1}{2}$"
15	8'-9" to 9'-$0\frac{3}{4}$"	9'-$0\frac{3}{4}$" to 9'-$4\frac{1}{2}$"	9'-$4\frac{1}{2}$" to 9'-$8\frac{1}{4}$"	9'-$8\frac{1}{4}$" to 10'-0"	10'-0" to 10'-$3\frac{3}{4}$"

TABLE IV -- Dimensions for principal closed string stairs with landings.

See Table V for Dimension "K"

Floor to Floor or Landing Height F		No. of Risers	Stair Pattern	Finish Dimension R	Substringer Dimensions S	A	E	Finish Stringer Dimensions G	J	T
7'-3"	7'-6"	12	B	8'-10½"	10'-10⅞"	8¼"	3 11/16"	5'-6 1/16"	6'-3⅞"	
7'-0"	7'-3"	12	A	8'-10½"	10'-9 3/16"	8"	3 7/16"	5'-5 3/16"	6'-3"	
7'-1¼"	7'-4"	11	D	8'-1"	10'-2 1/16"	8¾"	4¼"	5'-7⅞"	5'-5½"	
6'-1-½"	7'-1¼"	11	C	8'-1"	10'-0 7/16"	8½"	4"	5'-7"	5'-4⅝"	
6'-7¾"	6'-10½"	11	B	8'-1"	9'-10⅞"	8¼"	3 11/16"	5'-6 1/16"	5'-3⅞"	
6'-5½"	6'-8"	10	D	7'-3½"	9'-1¾"	8¾"	4¼"	4'-7 9/16"	5'-5½"	
6'-5"	6'-7¾"	11	A	8'-1"	9'-9 5/16"	8"	3 7/16"	5'-5 3/16"	5'-3 1/8"	
6'-3"	6'-5½"	10	C	7'-3½"	9'-0¼"	8½"	4"	4'-6 13/16"	5'-4⅝"	
6'-0½"	6'-3"	10	B	7'-3½"	8'-10⅞"	8¼"	3 11/16"	4'-6 1/16"	5'-3⅞"	
5'-10"	6'-0½"	10	A	7'-3½"	8'-9 7/16"	8"	3 7/16"	4'-5 5/16"	5'-3 1/8"	
5'-9¾"	6'-0"	9	D	6'-6"	8'-1 3/8"	8¾"	4¼"	2'-6⅞"	5'-5½"	
5'-7½"	5'-9¾"	9	C	6'-6"	8'-0 1/16"	8½"	4"	2'-6 7/16"	5'-4⅝"	
5'-5¼"	5'-7½"	9	B	6'-6"	7'-10 13/16"	8¼"	3 11/16"	2'-6"	5'-3⅞"	
5'-3"	5'-5¼"	9	A	6'-6"	7'-9 9/16"	8"	3 7/16"	2'-5 9/16"	5'-3 1/8"	
5'-2"	5'-4"	8	D	5'-8½"	7'-1 1/16"	8¾"	4¼"	2'-6⅞"	5'-5½"	
5'-0"	5'-2"	8	C	5'-8½"	6'-11 15/16"	8½"	4"	2'-6 7/16"	5'-4⅝"	
4'-10"	5'-0"	8	B	5'-8½"	6'-10 13/16"	8¼"	3 11/16"	2'-6"	5'-3⅞"	
4'-8"	4'-10"	8	A	5'-8½"	6'-9 11/16"	8"	3 7/16"	2'-5 9/16"	5'-3 1/8"	
4'-6¼"	4'-8"	7	D	4'-11"	6'-0 11/16"	8¾"	4¼"	2'-6⅞"	4'-5 1/8"	
4'-4½"	4'-6¼"	7	C	4'-11"	5'-11¾"	8½"	4"	2'-6 7/16"	4'-4½"	
4'-2¾"	4'-4½"	7	B	4'-11"	5'-10¾"	8¼"	3 11/16"	2'-6"	4'-3⅞"	
4'-1"	4'-2¾"	7	A	4'-11"	5'-9 13/16"	8"	3 7/16"	2'-5 9/16"	4'-3¼"	
3'-10½"	4'-0"	6	D	4'-0½"	5'-0⅜"	8¾"	4¼"			5'-11⅝"
3'-9"	3'-10½"	6	C	4'-0½"	4'-11 9/16"	8½"	4"			5'-10¾"
3'-7½"	3'-9"	6	B	4'-0½"	4'-10¾"	8¼"	3 11/16"			5'-9 13/16"
3'-6"	3'-7½"	6	A	4'-0½"	4'-9 15/16"	8"	3 7/16"			5'-8 15/16"

TABLE IV -- Dimensions for principal closed string stairs with landings.

See Table V for Dimension "K"

Floor to Floor or Landing Height F		No. of Risers	Stair Pattern	Finish Dimension R	Substringer Dimensions S	A	E	Finish Stringer Dimensions G	J	T
7'-3"	7'-6"	12	B	8'-10½"	10'-10⅞"	8¼"	3 11/16"	5'-6 1/16"	6'-3⅞"	
7'-0"	7'-3"	12	A	8'-10½"	10'-9 3/16"	8"	3 7/16"	5'-5 3/16"	6'-3"	
7'-1¼"	7'-4"	11	D	8'-1"	10'-2 1/16"	8¾"	4¼"	5'-7⅞"	5'-5½"	
6'-1-½"	7'-1¼"	11	C	8'-1"	10'-0 7/16"	8½"	4"	5'-7"	5'-4⅝"	
6'-7¾"	6'-10½"	11	B	8'-1"	9'-10⅞"	8¼"	3 11/16"	5'-6 1/16"	5'-3⅞"	
6'-5½"	6'-8"	10	D	7'-3½"	9'-1¾"	8¾"	4¼"	4'-7 9/16"	5'-5½"	
6'-5"	6'-7¾"	11	A	8'-1"	9'-9 5/16"	8"	3 7/16"	5'-5 3/16"	5'-3⅛"	
6'-3"	6'-5½"	10	C	7'-3½"	9'-0¼"	8½"	4"	4'-6 13/16"	5'-4⅝"	
6'-0½"	6'-3"	10	B	7'-3½"	8'-10⅞"	8¼"	3 11/16"	4'-6 1/16"	5'-3⅞"	
5'-10"	6'-0½"	10	A	7'-3½"	8'-9 7/16"	8"	3 7/16"	4'-5 5/16"	5'-3⅛"	
5'-9¾"	6'-0"	9	D	6'-6"	8'-1⅜"	8¾"	4¼"	2'-6⅞"	5'-5½"	
5'-7½"	5'-9¾"	9	C	6'-6"	8'-0 1/16"	8½"	4"	2'-6 7/16"	5'-4⅝"	
5'-5¼"	5'-7½"	9	B	6'-6"	7'-10 13/16"	8¼"	3 11/16"	2'-6"	5'-3⅞"	
5'-3"	5'-5¼"	9	A	6'-6"	7'-9 9/16"	8"	3 7/16"	2'-5 9/16"	5'-3⅛"	
5'-2"	5'-4"	8	D	5'-8½"	7'-1 1/16"	8¾"	4¼"	2'-6⅞"	5'-5½"	
5'-0"	5'-2"	8	C	5'-8½"	6'-11 15/16"	8½"	4"	2'-6 7/16"	5'-4⅝"	
4'-10"	5'-0"	8	B	5'-8½"	6'-10 13/16"	8¼"	3 11/16"	2'-6"	5'-3⅞"	
4'-8"	4'-10"	8	A	5'-8½"	6'-9 11/16"	8"	3 7/16"	2'-5 9/16"	5'-3⅛"	
4'-6¼"	4'-8"	7	D	4'-11"	6'-0 11/16"	8¾"	4¼"	2'-6⅞"	4'-5⅛"	
4'-4½"	4'-6¼"	7	C	4'-11"	5'-11¾"	8½"	4"	2'-6 7/16"	4'-4½"	
4'-2¾"	4'-4½"	7	B	4'-11"	5'-10¾"	8¼"	3 11/16"	2'-6"	4'-3⅞"	
4'-1"	4'-2¾"	7	A	4'-11"	5'-9 13/16"	8"	3 7/16"	2'-5 9/16"	4'-3¼"	
3'-10½"	4'-0"	6	D	4'-0½"	5'-0⅜"	8¾"	4¼"			5'-11⅝"
3'-9"	3'-10½"	6	C	4'-0½"	4'-11 9/16"	8½"	4"			5'-10¾"
3'-7½"	3'-9"	6	B	4'-0½"	4'-10¾"	8¼"	3 11/16"			5'-9 13/16"
3'-6"	3'-7½"	6	A	4'-0½"	4'-9 15/16"	8"	3 7/16"			5'-8 15/16"

TABLE IV continued.....

Floor to Floor or Landing Height F		No. of Risers	Stair Pattern	Finish Dimension R	Substringer Dimensions S	A	E	Finish Stringer Dimensions G	J	T
3'-2¾"	3'-4"	5	D	3'-3"	4'-0"	8¾"	4¼"			4'-11 5/16"
3'-1½"	3'-2¾"	5	C	3'-3"	3'-11⅜"	8½"	4"			4'-10 9/16"
3'-0¼"	3'-1½"	5	B	3'-3"	3'-10¾"	8¼"	3 11/16"			4'-9 13/16"
2'-11"	3'-0¼"	5	A	3'-3"	3'-10 1/16"	8"	3 7/16"			4'-9 1/16"
2'-7"	2'-8"	4	D	2'-5½"	2'-11 11/16"	8¾"	4¼"			3'-11"
2'-6"	2'-7"	4	C	2'-5½"	2'-11 3/16"	8½"	4"			3'-10⅜"
2'-5"	2'-6"	4	B	2'-5½"	2'-10 11/16"	8¼"	3 11/16"			3'-9 13/16"
2'-4"	2'-5"	4	A	2'-5½"	2'-10 3/16"	8"	3 7/16"			3'-9 3/16"
1'-11¼"	2'-0"	3	D	1'-7½"	1'-11⅜"	8¾"	4¼"			2'-10⅝"
1'-10½"	1'-11¼"	3	C	1'-7½"	1'-11"	8½"	4"			2'-10 3/16"
1'-9¾"	1'-10½"	3	B	1'-7½"	1'-10 11/16"	8¼"	3 11/16"			2'-9¾"
1'-9"	1'-9¾"	3	A	1'-7½"	1'-10 5/16"	8"	3 7/16"			2'-9 9/16"
1'-3½"	1'-4"	2	D	10"	11"	8¾"	4¼"			1'-10 5/16"
1'-3"	1'-3½"	2	C	10"	10 13/16"	8½"	4"			1'-10"
1'-2½"	1'-3"	2	B	10"	10⅝"	8¼"	3 11/16"			1'-9¾"
1'-2"	1'-2½"	2	A	10"	10 7/16"	8"	3 7/16"			1'-9 7/16"

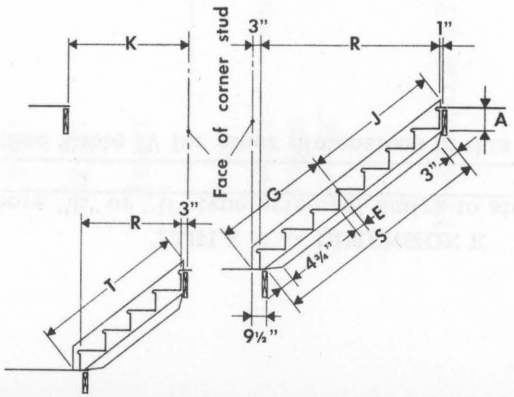

TABLE V -- DIMENSION K

Face of header above "L" or "U" type principal stairs to stud face at corner of landing.

(See Table IV for other dimensions of this type stair)

No. of Rises from Landing to Upper Floor	Pattern A	Pattern B	Pattern C	Pattern D
2	9'-2½"	8'-9½"	8'-5½"	8'-2½"
3	8'-5"	8'-0"	7'-8"	7'-5"
4	7'-7½"	7'-2½"	6'-10½"	6'-7½"
5	6'-10"	6'-5"	6'-1"	5'-10"
6	6'-0½"	5'-7½"	5'-3½"	5'-0½"
7	5'-3"	4'-10"	4'-6"	4'-3"
8	4'-5½"	4'-0½"	3'-8½"	3'-5½"
9	3'-8"	3'-3"	2'-11"	2'-8"
10	2'-10½"	2'-5½"	2'-1½"	1'-10½"
11	2'-1"	1'-8"	1'-4"	1'-1"
12	1'-3½"	0'-10½"	0'-6½"	0'-3½"

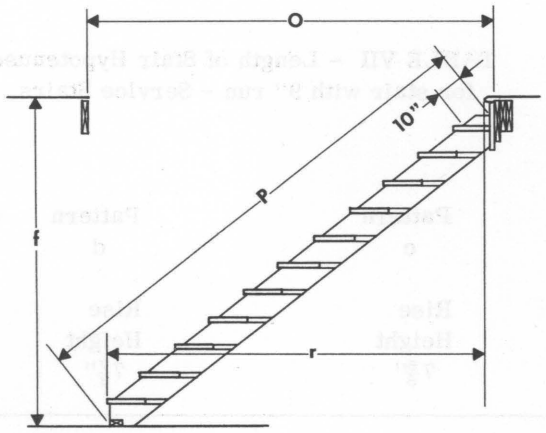

TABLE VI

Planning & Building Dimensions for open string, straight run service stairs.

Floor to Floor Height f	No. of Risers	Stair Pattern	Finish Dimension r	Finish String Length p
9'-4" to 9'-7½"	14	e	9'-11"	13'-5⅛"
9'-0½" to 9'-4"	14	d	9'-11"	13'-2$\frac{11}{16}$"
8'-8" to 8'-11¼"	13	e	9'-2"	12'-5"
8'-9" to 9'-0½"	14	c	9'-11"	13'-0¼"
8'-4¾" to 8'-8"	13	d	9'-2"	12'-2¾"
8'-1½" to 8'-4¾"	13	c	9'-2"	12'-0½"
8'-0" to 8'-3"	12	e	8'-5"	11'-4⅞"
7'-9" to 8'-0"	12	d	8'-5"	11'-2$\frac{13}{16}$"
7'-6" to 7'-9"	12	c	8'-5"	11'-0$\frac{11}{16}$"

TABLE VII - Length of Stair Hypotenuse
for stair with 9" run - Service Stairs

Number of steps	Pattern c Rise Height $7\frac{5}{8}$"	Pattern d Rise Height $7\frac{7}{8}$"	Pattern e Rise Height $8\frac{1}{8}$"
1	0-11 25/32"	0-11 31/32"	1'-0 1/8"
2	1'-11 19/32"	1'-11 29/32"	2'-0 1/4"
3	2'-11 3/8"	2'-11 7/8"	3'-0 3/8"
4	3'-11 3/16"	3'-11 27/32"	4'-0 1/2"
5	4'-10 31/32"	4'-11 25/32"	5'-0 5/8"
6	5'-10 25/32"	5'-11 3/4"	6'-0 3/4"
7	6'-10 9/16"	6'-11 23/32"	7'-0 7/8"
8	7'-10 3/8"	7'-11 21/32"	8'-1"
9	8'-10 5/32"	8'-11 5/8"	9'-1 1/8"
10	9'-9 31/32"	9'-11 19/32"	10'-1 1/4"
11	10'-9 3/4"	10'-11 9/16"	11'-1 3/8"
12	11'-9 9/16"	11'-11 16/32"	12'-1 1/2"
13	12'-9 11/32"	12'-11 15/32"	13'-1 5/8"
14	13'-9 5/32"	13'-11 7/16"	14'-1 3/4"
15	14'-8 15/16"	14'-11 3/8"	15'-1 7/8"